JOURNAL of the
SOCIETY of MOTION PICTURE and TELEVISION ENGINEERS

In This Issue

President's Convention Address
Motion Pictures and Television
Film Productions for Television
TV Studio Lighting Methods
Electrical Printing
Studio Magnetic Recording
High-Speed Photography
Underwater Cinematography
35-Mm Color Prints From 16-Mm
Laboratory for Color Film

THIS ISSUE IN TWO PARTS
Part I, December 1950 Journal
Part II, Index to Volume 55

DECEMBER 1950

High-Speed Photography

Several months ago the editors announced preparation of *High-Speed Photography*, Volume 3, the third reprint of high-speed photography papers, to include all articles on the subject published in the *Journal* since the appearance of Volumes 1 and 2 during 1949.

Publication date has been deferred until February so that the recently approved Bibliography can be included. The 71 pages of manuscript just cleared for publication will make about 30 *Journal* pages and will make up the most complete list of references ever published.

Previous volumes have been sold out because several companies placed quantity orders after printing was completed. To insure an adequate supply, members who will require a large number of copies should place their orders before February 1st or at least indicate to Society Headquarters that they will eventually require a large number. Single copy and large-lot prices will be available in January. Tentative price for single copies of Volume 3 is $2.00.

Journal of the Society of

Motion Picture and Television Engineers

VOLUME 55 DECEMBER 1950 NUMBER 6

President's Convention Address.....E. I. Sponable 559
Motion Pictures and Television (Convention Address).....
V. K. Zworykin 562
Motion Picture Production for Television.....Jerry Fairbanks 567
Lighting Methods for Television Studios.....H. M. Gurin 576
Electrical Printing.....J. G. Frayne 590
Motion Picture Studio Use of Magnetic Recording.....L. L. Ryder 605
High-Speed Photography of Reflection-Lighted Objects in Transonic Wind Tunnel Testing.....
E. R. Hinz, C. A. Main and Elinor P. Muhl 613
U.S. Naval Underwater Cinematography Techniques...R. R. Conger 627
35-Mm Ansco Color Theater Prints from 16-Mm Kodachrome.....
Adrian Mosser and Linwood Dunn 635
New Laboratory for Processing Monopack Color Film.....
Krishna Gopal 639
68th Convention..... 647
Society Awards..... 649
New Fellows; Journal; Honorary Members; Samuel L. Warner Memorial; Progress Medal
Convention Speech.....Terry Ramsaye 652
New Society Medal..... 653
Engineering Activities..... 654
Employment Service..... 656
New Members..... 656
Obituary..... 657
Papers Presented at Lake Placid Convention..... 658
Honorary Members and SMPTE Honor Roll..... 660

Arthur C. Downes
Chairman
Board of Editors

Victor H. Allen
Editor

Norwood L. Simmons
Chairman
Papers Committee

Subscription to nonmembers, $12.50 per annum; to members, $6.25 per annum, included in their annual membership dues; single copies, $1.50. Order from the Society's General Office. A discount of ten per cent is allowed to accredited agencies on orders for subscriptions and single copies. Published monthly at Easton, Pa., by the Society of Motion Picture and Television Engineers, Inc. Publication Office, 20th & Northampton Sts., Easton, Pa. General and Editorial Office, 342 Madison Ave., New York 17, N.Y. Entered as second-class matter January 15, 1930, at the Post Office at Easton, Pa., under the Act of March 3, 1879.

Copyright, 1950, by the Society of Motion Picture and Television Engineers, Inc. Permission to republish material from the Journal must be obtained in writing from the General Office of the Society. Copyright under International Copyright Convention and Pan-American Convention. The Society is not responsible for statements of authors or contributors.

Society of
Motion Picture and Television Engineers

342 Madison Avenue, New York 17, N.Y., Tel. Mu 2-2185
Boyce Nemec, Executive Secretary

OFFICERS

1949–1950

President
Earl I. Sponable
460 W. 54 St.
New York 19, N.Y.

Past-President
Loren L. Ryder
5451 Marathon St.
Hollywood 38, Calif.

Secretary
Robert M. Corbin
343 State St.
Rochester 4, N.Y.

Executive Vice-President
Peter Mole
941 N. Sycamore Ave.
Hollywood 38, Calif.

Editorial Vice-President
Clyde R. Keith
120 Broadway
New York 5, N.Y.

Convention Vice-President
William C. Kunzmann
Box 6087
Cleveland 1, Ohio

1950–1951

Engineering Vice-President
Fred T. Bowditch
Box 6087
Cleveland 1, Ohio

Treasurer
Frank E. Cahill, Jr.
321 W. 44 St.
New York 18, N.Y.

Financial Vice-President
Ralph B. Austrian
25 W. 54 St.
New York 19, N.Y.

Governors

1949–1950

Herbert Barnett
Manville Lane
Pleasantville, N.Y.

Kenneth F. Morgan
120 Broadway
New York 5, N. Y.

Norwood L. Simmons
6706 Santa Monica Blvd.
Hollywood 38, Calif.

1950

F. E. Carlson
Nela Park
Cleveland 12, Ohio

George W. Colburn
164 N. Wacker Dr.
Chicago 6, Ill.

Charles R. Daily
113 N. Laurel Ave.
Los Angeles 36, Calif.

John P. Livadary
4034 Cromwell Ave.
Los Angeles, Calif.

William B. Lodge
485 Madison Ave.
New York 22, N.Y.

Edmund A. Bertram
850 Tenth Ave.
New York 19, N.Y.

Malcolm G. Townsley
7100 McCormick Rd.
Chicago 45, Ill.

1950–1951

Lorin D. Grignon
1427 Warnall Ave.
Los Angeles 24, Calif.

Paul J. Larsen
4313 Center St.
Chevy Chase, Md.

William H. Rivers
342 Madison Ave.
New York 17, N.Y.

Edward S. Seeley
161 Sixth Ave.
New York 13, N.Y.

R. T. Van Niman
4441 Indianola Ave.
Indianapolis, Ind.

President's Convention Address

By EARL I. SPONABLE

Ladies and Gentlemen:

THIS CONVENTION brings back some old memories. The TRANSACTIONS of the Society record that we had a previous convention here just about this time twenty-three years ago. We met at Whiteface Inn, located about three miles northwest of here on Lake Placid. The Society members apparently liked this environment, for a second convention was held at Whiteface Inn the following year. Since that time, we have been oscillating between New York and Hollywood, with a stopover now and then at Chicago and Washington.

Our first meeting here was also my first as an Active Member of the Society. I was just a neophyte in the business at that time. I presented a paper entitled "Some Technical Aspects of the Movietone." That meeting in 1927 was practically at the beginning of commercial sound-on-film motion pictures.

Reading a bit in the TRANSACTIONS of that year is rather fascinating. Here is the first paragraph of the Progress Report:

> "Thomas A. Edison, when quizzed on his eightieth birthday as to the future of motion pictures, replied, 'Onward and upward.' He struck the keynote of the industry. One need not stretch the imagination far to paint a picture of the future in which sound synchronization, television, and stereoscopic principles are combined to give super entertainment and service. Some day we may sit at home and see a great play, enacted in a magnificent theater in a distant city, and hear the words of the actors and the musical accompaniment."

This passage, written twenty-three years ago, predicted accurately the home television of today. The prophecy seems well on the way to fulfillment.

Again, the TRANSACTIONS of that time listed 232 members of the Society. We now have 3,300. Then there were six Standing Committees: two of these, "Standards and Nomenclature," and "Theater-Lighting," dealt with engineering problems; while the other four (Papers, Membership, Publicity and Advertising) handled administrative matters. Today we have some 20 Engineering and 17 Administrative Committees, as well as the Headquarters Staff of eleven regular employees. The two-a-year TRANSACTIONS have long since been superseded by our monthly JOURNAL, which is recognized everywhere as the engineering record of the motion picture business.

PRESENTED: October 16, 1950, at the SMPTE Convention at Lake Placid, N.Y.

Anyone so honored as to be elected President of this Society wishes most fervently to pass the job on to his successor with the feeling that the Society has prospered under his guidance. I am proud to have served you during two most significant years in the Society's history. These two years have seen great challenges in our industry — competition from new forms of entertainment — increased production costs — the threat of another war — an inflationary national economy — and all the problems attendant on such far-reaching circumstances. We have come through these two years, on the whole, very well indeed. Let me review some of the high points.

One of the accomplishments to which we may point with pride is the publication of a number of extremely useful documents. These will, I hope, mark the beginning of an ever-increasing effort to make more generally available the scientific and technical advances resulting from the work of our membership. These documents include a guide to "Films in Television"; a reprint of a 30-page JOURNAL article on "Theater Television Today"; three volumes on high-speed photography; a tabulation of characteristics of color film sound tracks; a report on the basic principles of color sensitometry; and a reference file on 35-mm sound heads. All of these are in addition to the regular monthly JOURNAL. For the last two years the Editors have not found it possible to keep the number of JOURNAL pages within the authorized budget because of the substantially larger volume of valuable contributions.

A change of the Society's name to include the words "and Television," together with a revised constitution and bylaws, was approved by the membership during this two-year period. This change has resulted in a substantial gain in membership from the ranks of television engineers. Increased interest has been shown in television projects, standards and contributions to the JOURNAL of timely papers on television subjects. The current convention program reflects our augmented television activities.

Theater television, although still limited in scope, has become a reality. The Theater Television Committee has contributed largely to the general interest now being shown in this new medium, and this committee has also been responsible for coordinating the related interests of exhibitors, equipment manufacturers and the common carriers. Film is now a permanent part of television, and many of the motion picture standards developed by the Society have been adopted by the broadcasters. Several unique problems which appeared were referred to our Engineering Committees, and an outstanding example of the practical help provided by such committee work is the Televi-

sion Test Targets now available on both 16- and 35-mm film, currently being used in almost every television station.

Other test films, some supplied jointly by the Society and the Motion Picture Research Council, are coming into wider use than ever before. Recently a Test Film Quality Control Committee has been appointed to insure that the level of technical accuracy required by the published specifications shall be maintained.

Thirteen New American Standards affecting motion pictures have been formally adopted during the past two years, bringing the total to 60. Today 20 engineering committees are actively working on over 40 different projects.

It is, of course, quite impossible to record adequately here all the assistance given me by the members of the Society; I cannot let the opportunity pass, however, without mentioning the active and loyal support of Boyce Nemec and the rest of the Administrative Staff without which the work of the Society would be rather ineffective. Fred Bowditch has ably organized the engineering activities of the committees; and Bill Kunzmann be praised: I have been relieved of all worries about conventions. To all the rest, my sincerest thanks, and I am sure you will each continue to help my successor as wholeheartedly as you have helped me.

So much for the past; what of the future? We want more members, particularly from the television field. We are grateful for the sustaining support we have received, but we must have more if we are to carry on and expand to supply the services required in our field. We need to enlarge the JOURNAL to serve better both television and motion pictures. These problems are always with us, but the organization and running of our national conventions is becoming more difficult and complex as the Society becomes larger and the interests of its members more varied. I wonder whether the national conventions should be replaced by regional ones, with more emphasis on technical and less on social activities, or whether we would not do well, perhaps, to give up completely, in the near future, the two National Conventions a year and plan instead to hold only one National Meeting with the Local Sections taking more of the load in supplying forums for our speakers and papers for publication. This would constitute a major policy change — please think about it and give your new Board of Governors the benefit of your opinions. With your continued support, Edison's words "Onward and upward" will still be the motto of the Society and of the motion picture and television industries, as we look confidently toward the future.

Motion Pictures and Television

By V. K. ZWORYKIN

RCA Laboratories Div., Radio Corporation of America, Princeton, N.J.

Man, from the beginning, has sought to extend the range of his vision. Once upon a time he called upon the oracle or the soothsayer to overcome the barrier of time and distance. Our present, more skeptical, age relies instead upon the ingenuity of the scientist and engineer to translate past into present and to bring distant scenes within our immediate reach.

The means which accomplish this end are known to us as motion pictures and television. The fact that the development of motion pictures preceded that of television may be regarded as an historical accident—a consequence of the fact that the evolution of the electronic industry lagged behind that of the chemical industry. In fact, I am inclined to regard the historical sequence as an illustration of man's tendency to work out the more complicated problem first.

Viewed from the larger perspective of history, the two developments may well be regarded as simultaneous, being separated at most by a single generation. The present readjustments imposed by the arrival of television on the motion picture industry may well be likened to the readjustment which a slightly older child must undergo upon the arrival of the new baby. While the initial phase of this readjustment may be painful, presently each of the two children will lay its proper claim on the affections and attentions of its parents. More than that, each child will have a good influence on the development of the other. It is evident even now that the motion picture industry and television will complement each other, mutually increasing the effectiveness of their services, rather than compete for the favor of the public.

Pursuing the analogy a little further, it might have been hoped that the experience in raising the first child, motion pictures, might have smoothed the way for the second, television. Alas, that hope seems to have proved illusory. The disputes regarding frame frequency, aspect ratio, definition, etc., which marked the infancy of motion pictures are dogging our footsteps even now in television, impeding the adoption of internationally recognized standards.

The repetition of the same pattern in the development of motion

Presented: October 16, 1950, at the SMPTE Convention at Lake Placid, N.Y.

pictures and television is nowhere more evident than in the field of color. It was obvious from the start, in both motion pictures and television, that natural-color pictures were the ultimate objective. Black-and-white pictures were but a step along toward that goal, however important an interim role they have played and are playing. In both motion pictures and television, the black-and-white picture has enjoyed and will enjoy preference over a color picture as long as it is distinctly superior technically. Once the technical difficulties of color reproduction are overcome, the color picture will tend to displace the black-and-white picture even with a material difference in production costs.

Development of Color in Motion Pictures

But let us return to the early beginnings of color in motion pictures and television. In both fields the first workers attempted to solve the problem by the same, most obvious, method: the transmission and projection in sequence of the partial images in the primary colors, relying on the persistence of vision to fuse the successive color fields into a single natural-color picture. The first attempts to employ this "field-sequential" method in motion pictures were made by Friese-Greene in England around the turn of the Century. Albert Smith began to exploit it commercially in the United States under the name of "Kinemacolor" in 1908. Both inventors employed identical rotating filter disks in front of the camera and the projector. To reduce the required speed of the disk, they contented themselves with a two-color process, i.e., an orange and a blue-green filter.

One of the earliest findings with the two-color Kinemacolor process was that flicker effects were much more serious than expected. To reduce them to a level comparable with that attained with 16-fields/sec black-and-white film, it was found necessary not merely to double the film speed, but to increase it to 50 or 70 pictures/sec. Furthermore, moving objects showed a rainbow effect at the leading and trailing edge, corresponding to the shift of the object in the interim between the projection of successive monochrome fields. Film consumption was excessive in view of the high speed of the machine. Presently, as Frederic Talbot tells us, people tired of the novelty of so-called "natural-color" film and the expense of installing a special high-speed projector for this exclusive purpose was no longer balanced by a comparable return. Kinemacolor, with its field-sequential system of color projection, was a distinct failure.

With the exception of the Gaumont process, in which the three partial images were recorded and projected simultaneously on special

film, all subsequent commercial processes of color motion pictures concentrated on processes in which the color film could be projected by standard black-and-white projection equipment. Thus, the Eastman Research Laboratories, perhaps the first to recognize the importance of avoiding special equipment for the projection of color pictures, developed their old two-color Kodachrome positive film, in which successive frames on a negative obtained essentially by the Kinemacolor process were printed back to back and appropriately dyed with the complementary colors. Prizmacolor, introduced to the public in 1921, attained the same end of a two-color film suitable for standard projection by a different process incorporating numerous refinements. Both, in view of the field-sequential method of camera exposure, still retained the defect of rainbows on moving objects. They were finally eliminated by employing simultaneous exposure as well as simultaneous projection, a universal feature of all color motion picture systems. With the exception of the old Kodacolor process, introduced in 1928 for 16-mm motion pictures, all of these furnish true natural-color transparencies for projection with a standard projector. Kodacolor utilized a special lenticular film which was exposed and projected with a color line screen inserted in the lens.

The Newer Color Processes

The majority of the newer color processes employ color film in standard motion picture cameras. It may be either of the screen type such as old Agfacolor and Dufaycolor or of the tripack type such as Kodachrome, introduced in 1935 by Mannes and Godowski, as well as Ansco color and new Agfacolor. By contrast, the Technicolor process employs a special camera which exposes simultaneously three films through a beam-splitting system. I wish to point this out specifically to show that specialized equipment and processing is no bar to the success of a color system, *provided* that it is confined to the production end of the system. The quality of the resulting film and the ease of duplication are here the factors of primary importance.

So much for the development of color motion pictures. Even before the Kinemacolor process was launched, the brothers Andersen had applied for a patent applying the same field-sequential principle to color television. By 1929 James Logie Baird could demonstrate, in Glasgow, 20- to 30-line color pictures formed with a Nipkow disk flying spot system; the filters were mounted directly over the three successive aperture spirals of the disk. A similar disk served to present to the eye the three (red, green and blue) partial images in sequence. Ten years later the same inventor had raised the number

of lines in his color pictures to over a hundred. The field frequency was 100, as compared with 60 for black-and-white pictures. Needless to say, these color pictures could scarcely be classed as entertainment.

Even in those early days that method did not seem good enough for public acceptance. Efforts were renewed to attain color television pictures of entertainment quality using the field-sequential system. The number of lines was raised to a value comparable with that employed in black-and-white television. On the other hand, the field frequency was permitted to assume—and is still permitted to assume in the field-sequential system—a value less than three times the field frequency of black-and-white television. The resultant excessive color flicker confirmed the experience of Kinemacolor.

The Simultaneous System

The very same factor which sealed the doom of Kinemacolor—namely, the impossibility of either projecting Kinemacolor film with a standard projector or of projecting standard film with a Kinemacolor projector—finally caused RCA to abandon, in 1946, the field-sequential method in favor of a simultaneous system. This simultaneous system corresponds most nearly to the Gaumont color system and would, in fact, have been its perfect analog if the special film for the Gaumont system had had three frames of standard height placed side by side and if, in addition, standard black-and-white projectors would be able to utilize such film without change, projecting just one of the three film strips; and a Gaumont projector would be able, in turn, to project an ordinary black-and-white film. In short, the simultaneous system is perfectly compatible, as well as free from color flicker. However, just as the Gaumont system utilizes three times as much film material as a black-and-white projector, the simultaneous system demands three times the bandwidth of—or at least substantially greater bandwidth than—a black-and-white television transmission.

The final objective of confining a perfectly compatible color system with resolution comparable to that of black-and-white television in a standard television channel was achieved in the dot-simultaneous system by dot interlacing and the superposition of "mixed high" signals, analogous to the gray picture giving the finest detail in the Technicolor process. Color flicker is eliminated by the successive transmission of color dots at a rate of many millions per second. The camera is identical with that for the simultaneous system: in close analogy with the Technicolor camera, a beam-splitting system directs the light of the three monochrome partial images to three separate pickup tubes (corresponding to three separate negative

films). If the signals, combined by a transmitter sampling system, are applied to an ordinary black-and-white receiver (that is, the color film is reproduced on black-and-white film and run through a standard projector) a high-quality black-and-white picture results. If, in the same receiver, the black-and-white kinescope is replaced by a tricolor kinescope and receiver sampler (corresponding to the tricolor positive) the natural-color picture is reproduced. Finally, a black-and-white transmission will be correctly reproduced in black-and-white on the tricolor tube, just as a black-and-white negative printed on color film would yield a black-and-white projected picture. Thus, technical solutions have been attained in color television which are a close analog to the solution presently employed in color motion pictures. The development of a practical single tricolor pickup tube, in analogy to the use of color film in the motion picture camera, would round out the comparison.

It is my conviction that the path blazed by the motion picture industry, leading to compatible color motion pictures characterized by freedom from color flicker, is appropriate also for color television. The development of the dot-simultaneous system and of the tricolor kinescope demonstrates that it can be readily achieved. In this manner, I firmly believe, color television can be of greatest benefit to the public, for purposes of both entertainment and instruction.

Motion Picture Production For Television

By JERRY FAIRBANKS

Jerry Fairbanks, Inc., Hollywood, Calif.

SUMMARY: A new technique of motion picture filming has been developed, making important economies in theatrical production costs. Titled the "Multicam Process," this technique utilizes three or more cameras operating simultaneously from three or more different angles or on long, medium and close-up shots. The system permits a picture to be photographed in continuous action, cuts from one camera to another being indicated by "sync" marks on the selected film, and corresponding lines exposed on the sound film. The marking and "sync" devices are automatic. The Multicam Process makes it possible to film completely 30-min programs in a day, and to film "live" shows as they are televised.

DEVELOPMENT OF A NEW TECHNIQUE of motion picture filming now makes it possible to produce motion pictures at costs heretofore considered unlikely. The perfection of a multiple camera system tremendously cuts the time required to film all types of motion pictures, greatly lowers production expenses and makes it possible for television film producers to compete from a budget standpoint with kinescope-recorded shows.

The Multicam System developed in our research laboratories utilizes three or more 16-mm or 35-mm Mitchell cameras which can operate simultaneously, filming three or more different angles of a scene and getting long, medium and close-up shots at the same time. The procedure is similar to the use of three cameras in telecasting "live" video.

Combining the best advantages of both television and film shooting, the system permits a picture to be photographed in continuous action, including cuts from one camera to another.

During the shooting of numerous productions we have found that the new technique cuts previous production schedules by sometimes as much as 500%. *Nocturne*, a half-hour musical telecast weekly by KNBH in Hollywood, was completely filmed in a little more than three hours. Programs in the "Silver Theater" series, each a 30-min dramatic presentation, were filmed in eight hours. *The Triumphant Hour*, a feature-length production which called for many exteriors, star appearances, and much trick photography, was photographed in

Presented: October 17, 1950, at the SMPTE Convention in Lake Placid, N.Y.

four days. Such programs as "The Ed Wynn Show," "Truth or Consequences," "This Is Your Life" and "The Alan Young Show" were filmed simultaneously with the Los Angeles telecast or radio taping of the programs. In each of these cases 30 min of film was photographed in 30 min. "Major studio" schedules for the same type of filming would be from 10 days to two weeks. *The Triumphant Hour* would have been in production several months.

Numerous technical problems were surmounted during 36 months of research and experimentation in perfecting this system. Among the foremost of these was the invention of a marking device to synchronize picture and sound tracks. This was required because the new system called for cameras to be turned on and off numerous times during the filming of long sustained scenes. The only other alternative was to let all cameras run continuously from the start, necessitating a tremendous waste of negative film.

The problem was surmounted by the development of a device in each camera that leaves a synchronizing mark on the action film when the camera is up to speed, identifying the camera. Also, a similar device on the sound recorder exposes a line or lines on the sound film, identifying the cameras in operation throughout the scene. In this manner, the sound film becomes the key to the cutting and inserting of all scenes shot by the different cameras. The marking and synchronizing devices are entirely automatic and do not require cameramen to operate additional equipment.

The synchronizing devices are operated through the camera motor circuits and load-actuated time-delay relays. When the cameras are started, lights fog a small spot on each frame of the film passing through the cameras for a period of one second. One dot is marked on the negative for Camera 1, two dots for Camera 2, three for Camera 3, etc. At the end of the one-second period, the time-delay relays automatically switch off the action-film fogging lamps and instantly switch on the sound-film fogging lights. One line is marked on the sound film for Camera 1, two lines for Camera 2, etc. The film editor can tell which cameras were in operation during any one scene merely by glancing at the sound film.

The action film is marked by exterior fog lights that are reflected from the blimp glasses through the lenses. In 35-mm filming with Mitchell BNC cameras, the synchronizing fog lights are mounted in the interior of the cameras. Three lamps are mounted in the sound recorders in light-proof housings with small apertures adjacent to the film just under the main drive sprocket. The motion of the film over the apertures marks the fog lines which identify the cameras

and the synchronous start. In 35-mm filming, a different relay box is used because of the heavier motor of the BNC, but the principle is the same.

Only one extra wire is required to complete the synchronizing circuits to the cameras. This line is carried on the standard four-wire cable for the three-phase 220-v synchronous motor used to operate the camera.

Two pairs of wires comprise the signal circuit from the relay to the recorder. During location filming this synchronization is carried by two signal channels leased from the telephone company. These channels, of course, are in addition to the equalized recording channel and order wire which also are furnished by the telephone company during shooting at broadcasting auditoriums or locations. Portable equipment, featuring the synchronizing device, can be used when it is not feasible to lease telephone lines and when such lines are not available.

Perfection of 16-Mm Cameras

Another obstacle faced in developing the new system was the perfection of 16-mm cameras that could follow focus at all times and a view-finder that would give cameramen the exact image in the exact focus that was being recorded on film. Equipment was especially constructed by the Mitchell Camera Corp. to our specifications. Finders were coupled with camera lenses so that an adjustment of the finder focus would correct for parallax and camera lens focus. In short, equipment has been perfected so that if a scene is in focus on the finder it also is in focus on the film (Fig. 1).

Initially the cameras were mounted on standard tripods which, in turn, were mounted on three-wheel dollies equipped with caster wheels. Experience showed, however, that when the tripods were moved forward and then reversed or moved at a slight angle, the caster wheels caused an irregular movement of the cameras as the wheels shifted their position. This was undesirable as it caused a shift in the pictures being photographed during the camera movement. As a result, new-type tripod structures were perfected which permit steering of the tripod wheels from the panning handles of the cameras. The improved camera-supporting tripods can be steered for movement in any desired direction at any desired moment.

This new three-wheel dolly and tripod stand is fitted with 5-in., 1.5-in. doughnut, semisolid tires. To steer it, the operator rotates a motorcycle-like grip handle which causes all three wheels to turn at the same time in the same direction, permitting a complete 90°

movement of the tripod (Fig. 2). The stand also can be used as an improved tricycle-type dolly by locking the two rear wheels and steering by the front wheel.

The steering handle is mounted on the right side of the standard panning and tilt head so that the follow-focus knob can be operated by the cameraman. The steering handle is also the panning and tilt handle and the motor switch is conveniently mounted on the handle.

For rapid raising and lowering of the stand, a screw-actuated elevating device is operated by a hand wheel. Telescoping supporting rods make for rigidity for all operating heights.

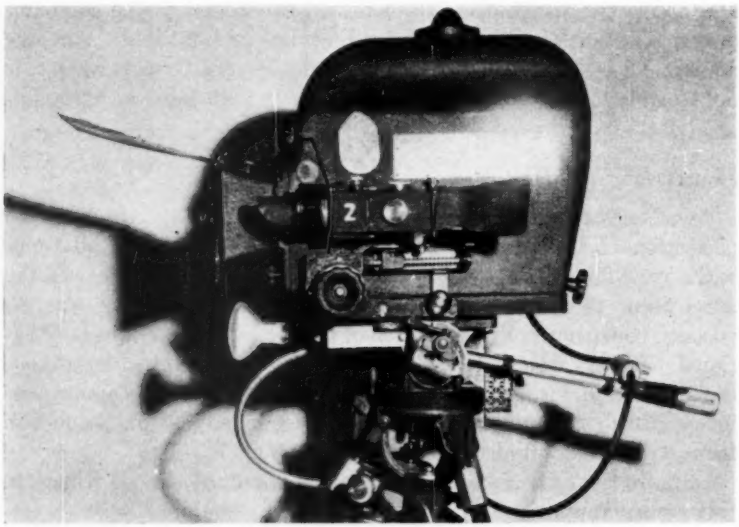


Fig. 1. A side view of the Multicam Camera. Finders are coupled with camera lenses so that an adjustment of the finder focus corrects for parallax and camera lens focus.

Eyelights have been mounted below the matte box on each camera blimp as well as over the blimps, to be used or not as the operator desires (Fig. 3). Each has a control mechanism to regulate the intensity of the light so that it will match the general set lighting. A transformer operated from the motor circuit with rheostat control supplies the electricity.

Each camera blimp is equipped also with an action light so that the cast and technicians will know exactly which cameras are in operation and the director will know if the scene is being filmed according to

plan. The action lights operate only if camera motors actually are running. Thus, they are used, too, as an instrument to notify the operator if the camera motor develops trouble during a scene. Camera cables, in many instances, are suspended overhead in sets to eliminate as many ground cables as possible.

A departure from previous motion picture methods, the new process required the development of a much faster and more efficient stage-operation technique and production system. General procedure, heretofore, has been to set up a tentative timetable of scenes to chart the course of production. This served more or less as a guide

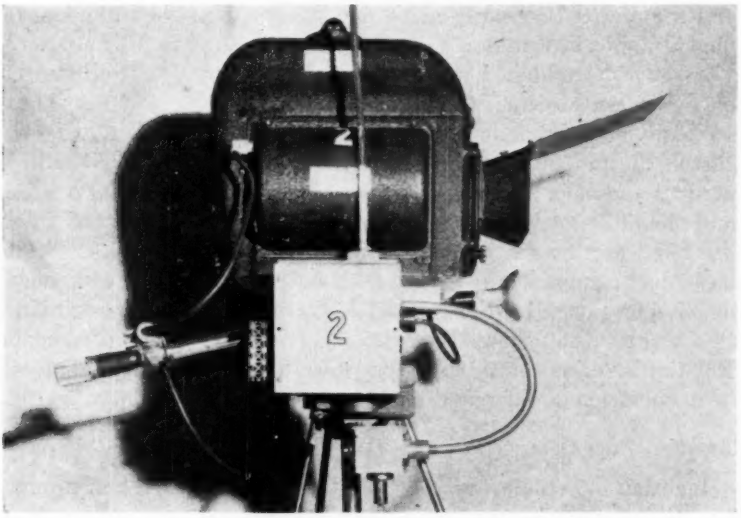


Fig. 2. A side view of the Multicam Camera showing motorcycle grip handle which is used to steer equipment. Eyelight transformer box and control are also shown.

to the construction department and set decorators. Players seldom memorized lines more than a day in advance of shooting and usually only for the scenes to be filmed. Camera angles were determined on the spot and rehearsals held while the technical crew stood by. The director in many instances was the only one who had knowledge of the master plan. Details were left until the night before shooting. Technicians and cast members learned about them the day of filming.

Under the Multicam System every detail is completely planned in advance. Sets and decorations for the entire screen play are con-

structed and dressed in advance. The cast, which has rehearsed on another stage, is as prepared as it would be for the opening night of a stage play. Every camera movement is planned long in advance on paper and all lighting is ready. One rehearsal is held on the stage. Its purpose is to give the camera operators the opportunity of executing what has been planned for them. The entire scene is then filmed, with the three cameras getting the various angles and long, medium and close-up shots. The average scene under the Multicam System runs many times longer than the average scene under the conventional method. Rarely is the footage under five minutes and seven to eight minutes is the average. In some instances, when a minimum of sets and complicated action is called for, 30 min of finished film can be photographed in 30 min.

A set of "production scripts" prepared for every technician and player is the key to the entire stage-operation technique. These script layouts outline in detail every camera movement and cues for cutting in and out of scenes. Each camera is designated with a number and color to identify any particular camera and its position and field of coverage. Cameramen and technicians study their "scripts" in advance just as thoroughly as do the players. While individual cameramen receive layouts covering only their own schedule of operations, the director and cast are given a master "production script" that shows the plan for the three or more cameras. Relative markings in the story script also show the cameras that will be in operation at any particular time in the story continuity.

Lighting Techniques

Lighting of sets always has been an important factor in production time. Lighting under the Multicam System averages less than five minutes and in many instances there is no loss of production time at all as every set is prelighted. The time-saving factor here added to the time gained by shooting only long, sustained scenes totals a huge saving in costs.

Perfection of the lighting technique also required many months of experimentation. The problem was to perfect a means of lighting a set so that no matter where the actors moved the light would be uniform. At the same time, it was necessary to devise a system that would practically eliminate cables from the stage floor. This was a "must" because the Multicam System requires the quick and easy movement of camera and sound boom equipment during shooting.

The main lighting system, as it has been developed, consists of banks of 300-w reflector lights. These banks are hung so that the

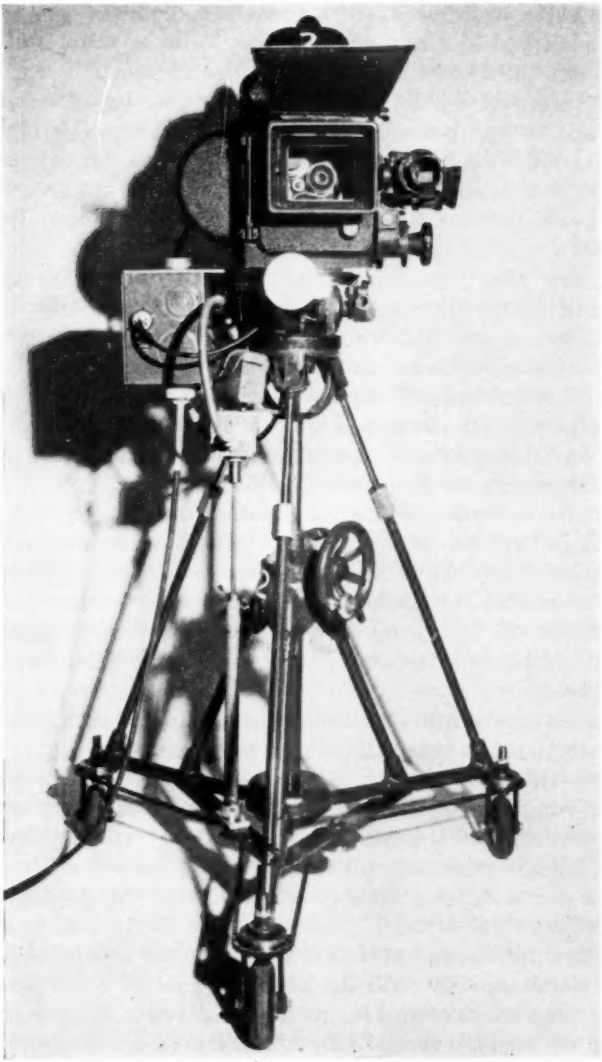


Fig. 3. Front view of Multicam Camera, showing camera equipment especially constructed by the Mitchell Camera Corp. and tripod equipment especially constructed by Mole-Richardson, Inc. Note the eyelight located below matte box, viewfinder arrangement, action light and hand wheel to operate screw-actuated elevating device. Guards over wheel chains have been removed for the photos. The three wheels are able to turn at the same moment in the same direction, permitting a complete 90° movement of the tripod.

tilt and swing adjustment can be made from the floor. This method makes for speed in giving an even, over-all illumination of the set, and when properly used, avoids dark or hot spots.

Back- and effect-lighting are handled in standard studio procedure with incandescent spotlights mounted on parallels. Once these are adjusted, they remain the same throughout shooting of the particular set. Smaller banks of reflector lights are used on the floor for side lighting. Cables for lamps and all electrical equipment are suspended.

The floor also is used as an aid in our lighting. A very light-colored floor covering, suitable to dolly on, is used to help eliminate chin, nose and eye shadows. Where the floor is in the picture in long shots, rugs, of course, are used. The combination of this flooring and bank lighting gives an over-all modeling that is photographically pleasing. It eliminates the unflattering shadows that live television lighting seems to accentuate. It also does away with the accentuated make-up that is often used in live telecasting.

With the exception of the synchronizing marking system, sound recording offered no major problems. Multiple recorders are used in the filming of long shows, saving the expense and work of developing larger magazines. Regular studio sound equipment, with a few innovations of our own, is used. Additional microphones are spotted overhead out of camera range to obtain complete coverage of the entire set.

Cast rehearsals, without camera and lighting equipment, are held on a nonshooting stage with similar props and furniture available. This prevents the tying up of the main sound stages and the expensive equipment located there. Here the director works out all his "business" and the cast familiarizes itself with the dialog and action. While rehearsals are thorough, they are not as demanding as those necessary for a live show which involve working under lights and with cameras.

The new technique was perfected, too, for the filming of live programs simultaneously with the actual telecast of a show. Special 1200-ft magazines are used for our 16-mm cameras, and the Eastman Kodak Co. prepares special 1200-ft negative film rolls to our specifications for this type of work. For 35-mm filming, 2000-ft magazines are used. An intercommunications system has been built so that cameramen can receive instructions in much the same manner as a live-video cameraman. This system also is available to us during filming on our stages. Tests, however, have proved that the "pro-

duction script" method gives excellent results and that earphones are unnecessary during stage shooting.

Quality in all our filmed programs is as good as in any "major studio" motion picture. Prints have proved that the system provides lighting, sound and clarity of picture far superior to those produced by the best kinescopes made to date. This has been proved beyond question several times by alternating, in a sample reel, footage from one of our programs and footage from a kinescope of the same show. The difference is startling, especially when seen on a closed circuit.

The ultimate aim of kinescope recordings is to obtain a quality comparable to live television or film. Realization of this goal is still many years away and current kinescoping leaves much to be desired. It remains to be seen, even when kinescopes are perfected, whether they will be even as acceptable as film. At present, photographing from a tube of 525 lines is similar to photographing a newspaper engraving. Imperfections in the engraving (and electronic lines of the tube) are always transferred to the copy.

This new method of film production does away with all the objectionable features of kinescopes and makes it possible for a star to do an entire series in a short period of time, not tying him to a regular weekly schedule. The show can be filmed in Hollywood, Chicago or New York at a time convenient to the actor and can be released whenever the sponsor desires. Not only is the actor's appearance protected, but so is his performance. Retakes always can be made if necessary. Furthermore, the technique catches all the spontaneity of live video because the players go through the story in much the same way as they would for a stage play.

By preplanning every move, streamlining stage-operation techniques and minimizing waste footage and coverage, shooting time is cut many times below what formerly was thought possible. The film, in a sense, is precut and an efficiency in production obtained that never before has been equalled. The net result is a tremendous saving in costs.

The savings in production costs have attracted the attention of many producers. Negotiations now are under way for use of the system by several of Hollywood's foremost studios.

Lighting Methods for Television Studios

By H. M. GURIN

National Broadcasting Co., New York

SUMMARY: A brief review of the characteristics of a highly sensitive television camera tube relative to sources of illumination is given. Recent improvements in special fixtures and facilities that have contributed to more rapid adjustment and better directional controls are discussed. There are relationships between staging and lighting of sets, and consideration of capabilities has produced some definite rules for normal studio operation. It is important that staging and lighting be carefully studied and planned in detail before camera rehearsals begin.

One of the most significant contributions to the rapid advances in television has been the development of a highly sensitive camera pickup tube. In scenes reproduced by a television system, the lighting on the set has the most obvious and direct bearing upon the quality of the television image. The relationship, therefore, between the pickup tube, the light requirements and the lighting methods to produce a picture of the original scene which is as pleasing as the technique and methods allow, is of primary importance.

The characteristics of the most popular pickup tube currently in use in many studios, type No. 5820* image orthicon, have been well described elsewhere, but for the sake of more clearly explaining the considerations in devising lighting methods now employed, they will briefly be repeated here. Figure 1 shows its spectral sensitivity curve, and Fig. 2 the relative sensitivity with respect to other camera pickup tubes previously used. It is important to note that the spectral curve of the No. 5820 image orthicon approaches the average eye sensitivity curve and leads one to expect intuitively that a subject will appear in a television screen as a comparable luminescent body in a manner similar to the eye, regardless of the illuminant used. There is no question that a high infrared response in a pickup tube will produce absurd gray scale renditions of certain subject matter which reflect infrared readily. However, with the introduction of an infrared cut-off filter, "normal" black-and-white pictures can be obtained. A

Presented: October 16, 1950, at the SMPTE Convention at Lake Placid, N.Y.

* R. B. Jones, R. E. Johnson and R. R. Handel, "A new image orthicon," *RCA Review*, vol. X, No. 4, pp. 586–592, Dec. 1949.

similar situation could be imagined in the blue end of the spectrum. Fortunately, by the use of an approximation to the eye-sensitivity curve, one would automatically safeguard against any unusual effects even though the color sensitivity of the eye does not enter the problem

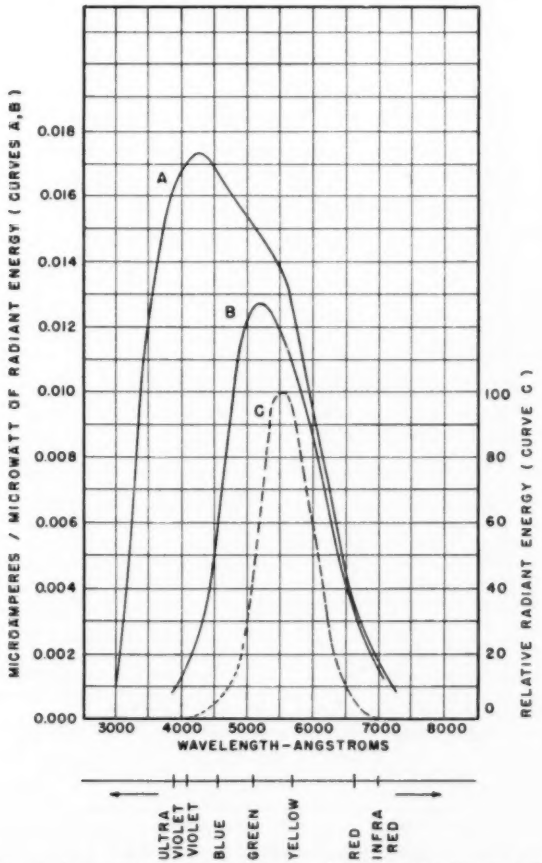


Fig. 1. Spectral sensitivity characteristic of Type 5820 image orthicon with and without filter for equal values of radiant flux at all wavelengths; Curve A is without filter; Curve B is with Wratten No. 6 filter; Curve C is spectral characteristic of average human eye.

directly in viewing a black-and-white picture. In practice, if the eye accepts the combination of light source and material reflectance as being "natural," the results in terms of black-and-white on the television screen will also be acceptable. Actually, with incandescent

light there is probably no great necessity of using the filter as indicated on the previous curves with the No. 5820 image orthicon, since the color components which the filter attenuates are present to only a small degree. With fluorescent light, which has much more energy in the blue-violet region, the use of the No. 6 Wratten filter may be justifiable.

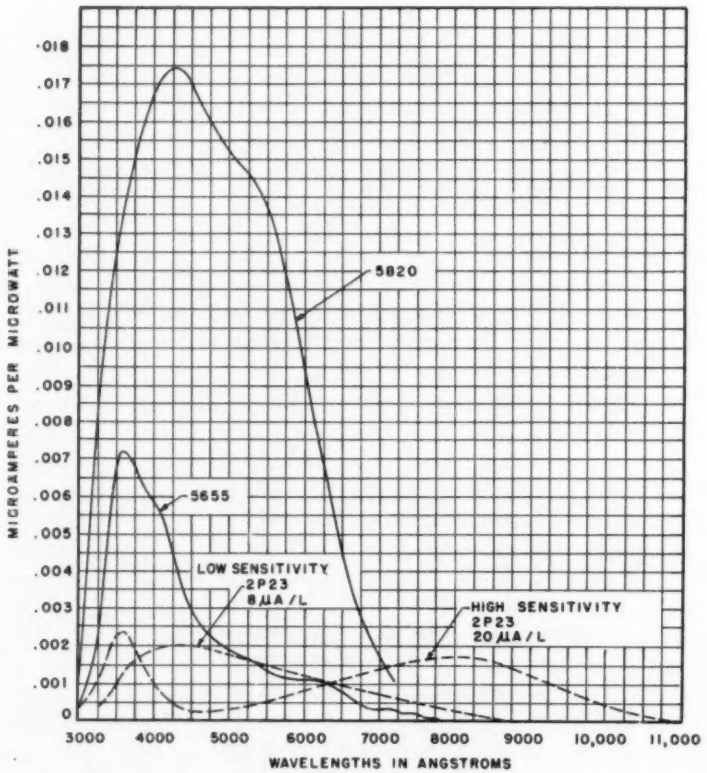


Fig. 2. Spectral response characteristic of various image orthicons.

The introduction of the No. 5820 image orthicon with its higher sensitivity has greatly reduced the light levels now required for good performance. It is no longer necessary to provide the high lighting levels in a studio which were required with previous types of pickup tubes. Thus, emphasis has shifted from providing lighting with as

little associated heating as possible, which is characteristic of fluorescent sources, to providing lighting sources of extreme versatility.

Incandescent sources can be diffused or highly concentrated and can be dimmed or doused easily. In addition they are more maneuverable, take up less installation area, and are simpler and cheaper to install and maintain. With the diminished lighting levels now usable for obtaining satisfactory pictures, the heat generated with incandescent lamps assumes only minor importance as compared to the operating advantages which can be gained by their use. In small areas, however, where heat dissipation or air conditioning is a problem and where maneuverability or special lighting techniques are not essential, fluorescent lighting may yet have useful application.

The minimum lighting for a picture which is good technically is the illumination level on an average subject which will enable a camera to produce a picture of acceptable signal-to-noise ratio. It is apparent that the light reflected from the subject rather than incident light is useful to the camera and therefore the subject material will be assumed to have average reflectance determined from normal television practices and the "base" or general illumination will be uniform where it is used. Under such conditions the recommended average lighting levels are those capable of producing a picture of good technical quality (see Table I).

TABLE I. Average Incident Light Required for RCA Image Orthicon No. 5820

Lens Stop, *f*/1.9	2 – 4 ft-c, Incident Light
2.8	4 – 8
3.5	6 – 12
*5.6	12 – 32
*8	32 – 65
11	60 – 120
16	120 – 240

*Normally used

It is recognized that this will furnish only a starting point for the wide variations in subject lighting which may be called for to obtain dramatic effects dictated by the mood and impression the producer wishes to create. In many cases it may be necessary to operate under conditions which do not satisfy requirements for a good technical picture but which do create the desired illusion.

The field of dramatic lighting is so broad and subject to so many psychological and personal factors that it does not lend itself to precise analysis. It is the purpose of this paper to present several operating

methods in a mechanical "sense" rather than in an artistic approach, leaving to the producers' talents and imagination the exploitation of the tools provided to the best advantage.

Functionally, television studio lighting equipment may be grouped into three distinct types as follows with their appropriate accessories: (1) floodlights; (2) spotlights; and (3) strip lights.

Floodlights are used primarily to furnish the "base" or general illumination and should provide a uniform, broad distribution of light. This has been rather satisfactorily accomplished by the use of a lightweight, open aluminum reflector capable of handling interchangeably a variety of lamps ranging from 500 to 2000 w. For improving diffusion, inside frosted lamps are preferable; and if even more diffusion is desired, a spun glass filter can be mounted across the reflector opening. Clusters of small sealed-beam reflection lamps have also been used successfully to obtain somewhat higher levels of incident light for general illumination. Where the flexibility in handling of equipment and space requirements are not critical, fluorescent lamps in suitable reflectors can also be used for floodlighting. In dramatic sequences where the light beam pattern must be very carefully controlled, a conventional Fresnel spotlight set for proper beam spread with a spun glass diffuser can be especially helpful.

For illuminating cycloramas, conventional strip lights with sealed-beam reflector lamps can be used to excellent advantage. Spread lens roundels and diffusers are also available for modifying light beams of individual lamps. Some care must be exercised, however, to adjust properly the angle of incidence so that the surface illumination is not too "hot" along the edges.

Spotlights are probably the most important lighting fixture in the studio today. Together with the appropriate accessories, such as barn doors, snoots,* adjustable irises, and diffusers, spotlights provide the most flexible medium for obtaining the maximum number of artistic effects.

They are used primarily to supply the key or principal illumination which falls on a subject or at a point where important action takes place to set the mood of the scene. Spotlights are an essential element in providing modeling light to enhance the appearance of a subject particularly where texture is involved.

Since the television image is a two dimensional picture reproducing a three dimensional scene, the importance of separating the most important element of picture interest from the surrounding backgrounds

* Appliances which can be fitted on the front of the lamphouse in order to adjust or shape the beam pattern.

cannot be overemphasized. This effect can be achieved with the proper use of spotlights by backlighting; at the same time the artistic effect of glistening highlights in the hair is added.

One of the most important limitations in a television system is the contrast range which can be handled to permit distinguishing detail in the shadows. This range is restricted for most purposes to 40:1 but is frequently less when the program is recorded on film for retransmission by television. This limitation makes the use of fill-light a significant adjunct to the modeling light and may be obtained by diffused spotlights or suitable floods. The proper use of fill-light also helps to remove any harsh lines and soften the contours particularly around the lips, nose and chin.

In theatrical presentations, one of the effects commonly encountered is the "follow-spot." While this method of illumination is very effective for a long over-all view, television usage is also concerned with a close-up of the subject and unfortunately the follow-spot usually puts the performer in a very harsh and unfavorable position in which imperfections, normally unobserved by remote inspection, are highlighted. Consequently, the follow-spot must be used judiciously.

Other special effects such as venetian blinds shadows, fire-lighting, cloud effects, etc., are obtained with spotlights having adjustable irises or by a projector with a motor driven "effects disc" which create the illusion of movement.

Eliminating Excessive Top-Light

One of the most frequent criticisms received in television was that most of the light seemed to come from above, resulting in highlights on the top of the head, the bridge of the nose and on the shoulders, leaving deep shadows around the eyes, nose and chin, and thereby making the subject most unattractive. These effects were due to the necessity of mounting most of the lighting equipment on the ceiling to give the maximum mobility to the cameras and microphone boom on the studio floor.

The seriousness of this problem was recognized and some steps to correct this fault were devised by using the inverted pyramid arrangement of lights whereby the fixtures in the center of the studio were placed at the lowest possible point to clear any floor-mounted equipment and the other fixtures raised upward toward the walls. This system, however, was found not flexible enough for studios where scenery shifting was frequent and where no two program set arrangements were identical, as in the case of a series of dramatic performances. As a result, a new pantograph fixture was developed and is

shown in Fig. 3. The principal advantage gained was the ability to raise and lower the light source to any given point thereby avoiding steep angles for front and side lighting, and doing this without sacri-

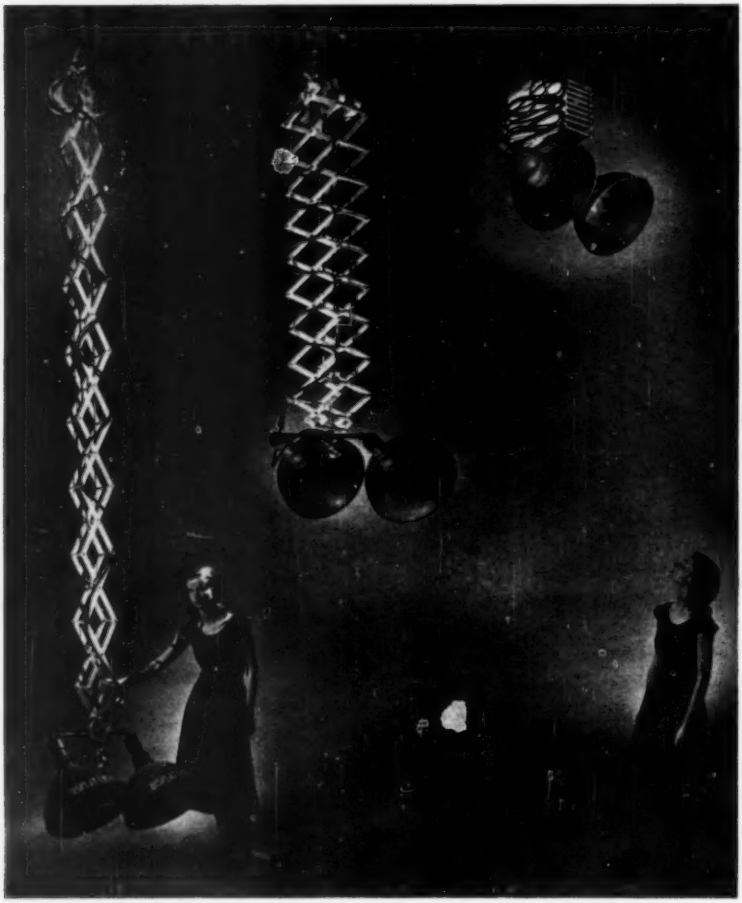


Fig. 3. Pantograph fixture for vertical adjustment of lighting units.

ficing the ability to rotate and tilt it for the proper directivity. It was also apparent that the number of floor lamps normally required for fill-light could be reduced, thereby extending the freedom of action of the studio cameras. For maximum coverage with a minimum of

actual handling, a sufficient number of pantograph units (one for every 15 sq ft of floor area) should be provided. Experience has proven further that sets of varying heights could also be more readily accommodated without undue rehanging or changing of the overhead structure from which the spotlights, floods, etc., were supported.

Recently, overhead tracks, placed sufficiently close and running the length of the studio, were installed and the lighting fixtures were hung on trolleys so they could be pushed to any desired point along the track length. Figure 4 illustrates how the installation appeared

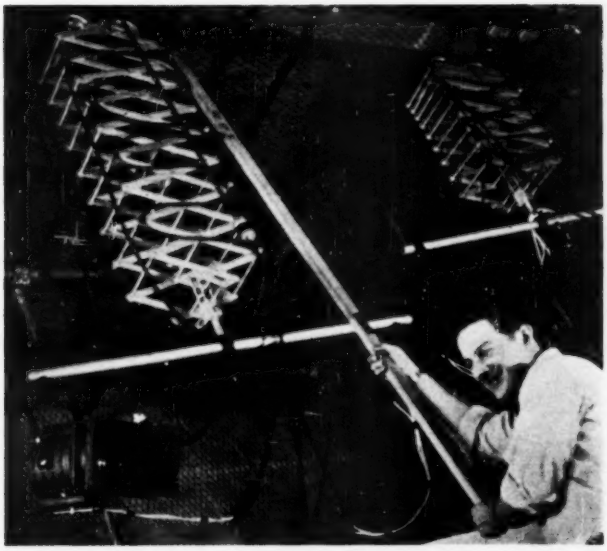


Fig. 4. Pantograph units on overhead tracks, Studio B, NBC Uptown Studios.

upon completion a short time ago. While it is anticipated that the length of time in setting up the lighting arrangement for a particular performance will be diminished and that fewer fixtures will be required in the studio, the installation has not been in use long enough to permit accurately evaluating its merits.

Inasmuch as the television studio floor must be kept as free of obstructions as possible for maximum flexibility in scenery arrangements and camera movement, the structure for supporting the lighting equipment itself becomes of utmost importance. One of the practical systems devised at NBC was a fixed gridiron of 1½-in. pipe, 4 to 6 ft

on centers, and as close to the ceiling as possible with clearance for raceways, ductwork, pipes, conduit, sprinklers, etc. The reason for mounting the grid close to the ceiling is to permit the erection of high sets without the necessity of an expensive and time consuming rehanging and installation of the grid when sets higher than the usual 10 ft are called for in a particular program.

It is from the fixed grid that the adjustable pantograph is usually supported. Recently a series of pipe battens suspended from the permanent grid by lines and pulleys have been hung across the entire ceiling of one of the newly modified television studios (Fig. 5). The

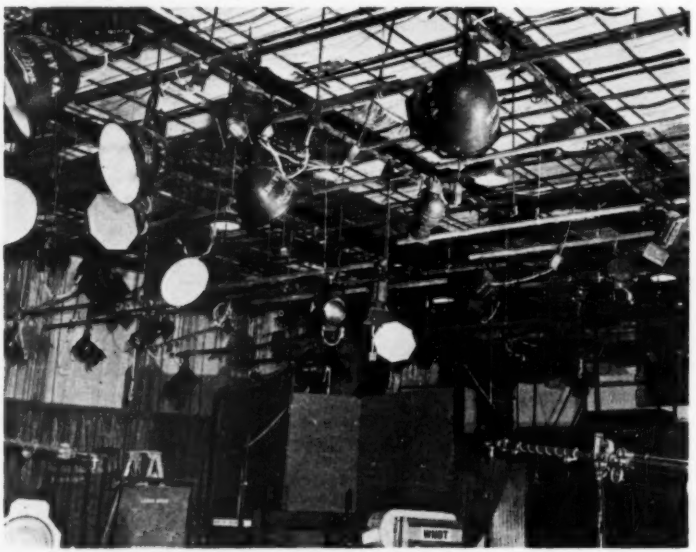


Fig. 5. Overhead batten lighting system, Studio 3A, Radio City, New York.

batten permits the raising and lowering of an entire series of lamps and it is envisioned that if additional unit flexibility is desired, the pantograph can be hung on the batten.

It would be advantageous to be able to walk over a grid on a catwalk for adjustment of scenery or relocating lighting fixtures, but the reduction in the effective studio height in most cases would be undesirable. Catwalks on the walls of the studios are even less desirable than above the grid because of the limited areas which can be served to advantage and because of the space under them which is obstructed

from overhead lighting. In any case, whatever structural appendages are included in a television studio, careful consideration must be given to the scenery and sets which are to be used to avoid any interference in erection and handling.

Developing Flexible Electrical System

In order to cope with the variety of program material usually encountered in a television workshop studio, a flexible electrical system of controls is of considerable importance. Practical considerations have limited the present systems to a-c power and while certain advantages are recognized for d-c power, this discussion will be confined to the former method. The electrical system for television lighting generally consists of a system of power input, a system of controllers, a central terminating point for conveniently energizing a number of branch circuits, and a system of branch outlets permanently and conveniently installed and distributed around the studio working area.

It has been found that for studio areas below 4000 sq ft, approximately 30 to 40 w/sq ft, installed, should provide ample power. For studios above 4000 sq ft, 15 to 25 w/sq ft, installed, should be sufficient. This does not imply that the total power indicated would actually be used but does apply to a unit area for the maximum requirements (lens stop $f/16$).

For controls, a master switch to control all the power to the studio, except work lights, is a prerequisite for total blackouts. This effect can be more readily obtained much more rapidly and with less complications electronically at the video console. However, black-outs for a particular area within a studio are desirable and may be obtained by subdividing the studio and using a number of submaster switches to extinguish relatively large amounts of illumination.

A further step in providing a flexible lighting system includes the use of dimmers. Several installations have been completed in which power is fed to a series of transformer-type dimmers and then fed to a number of branch circuits. By breaking down the available lighting power through the main, submaster and individual branch circuits through the dimming system each outlet can be individually controlled. The extent to which dimming can be used must be governed by the effective change in color temperature of the illuminant and its resultant influence on the subject. The use of dimmers should, therefore, be avoided in reducing the light on a live subject or on backgrounds which have colors; but dimmers may be used for rapid transition effects. It is worth noting that all the switches and controls can be operated under conditions of low illumination with a high

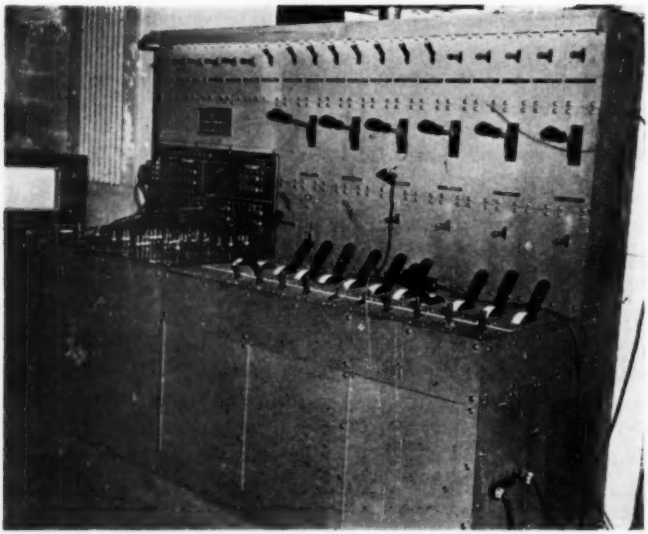


Fig. 6. Patchcord switchboard and dimmer panel, Studio B, NBC Uptown Studios.

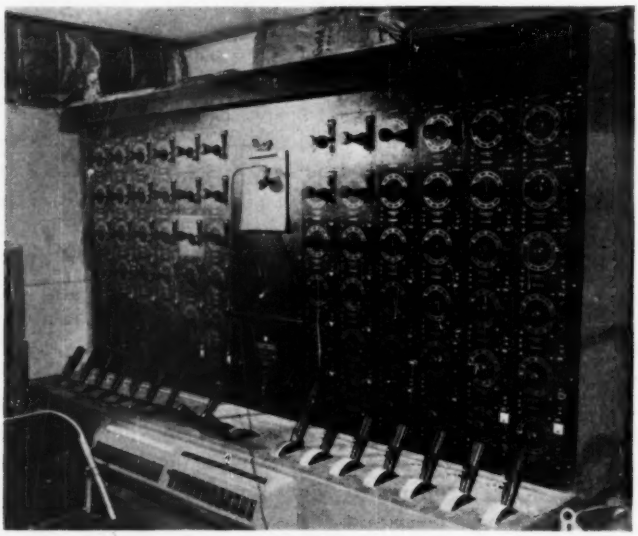


Fig. 7. Rotating selector switchboard and dimmer panel, Studio 3A, Radio City, New York.

degree of accuracy and a minimum of noise. Typical installations are illustrated in Figs. 6 and 7.

From the central terminating point, branch outlets, approximately one to each 20 to 30 sq ft, are distributed to the ceiling grid from raceways having pigtail connectors and to outlets around the periphery of the studio. Where a fixed stage is included within a studio, floor pockets along the sides and near the edge are very useful. In a general purpose studio it has been found that three to four times as many outlets as branch circuits should be installed.

Experience has shown that the painting of scenery for monochromatic rendition on television need not be confined to varying shades of gray. Instead, the use of colors on sets should be encouraged particularly since it has been found to provide a definite stimulus to the performers as well as to audiences. This practice, however, is guided by a thorough knowledge of the translation of the colors to the gray scale on the television system under known operating conditions. Using a light source of approximately 2900 K (degrees Kelvin), 111 different shades of cold water paints have been calibrated to a corresponding shade of gray in a 10-step gray scale ranging in relative density from .03 to 1.5, similar to the test chart of the Radio and Television Manufacturers Assn., as reproduced by a standard RCA television camera chain with a No. 5820 pickup tube. In general, dead white paints and highly reflective surfaces, such as enamels and chromium plated materials, are avoided. Similarly, very dark paints, dark velour drapery and dead black surfaces are also avoided. It has been found that the desired contrasts can be achieved by accurate and independent control of the incident light striking backgrounds and/or objects to obtain a given amount of reflectivity from these surfaces.

With suitable television equipment, proper light sources, flexible fixtures and adequate facilities and controls, the ability to obtain consistently good television lighting depends on the skill and cooperation between the technical staff and the program department. It is particularly important, where time and money are involved, that each is aware of what the other is striving for. From the very first step in creating a set design, the technical staff should be kept fully informed of the intentions and desires of the program group. Prerehearsal conferences are necessary to make sure that the set designer does not show shadow lines from light coming from the right when the actual source in the studio comes from the left. For flawless performances, rehearsals must include lighting cues to insure the proper dimming, black-outs, table lamp and room light switching, etc., and that they

Fig. 8. Test pattern photographed on control booth monitor.

Fig. 9. Test pattern photographed on conventional home receiver by a member of the technical staff.

are accurately timed. • Retakes are impossible and mistakes must be eliminated as much as is humanly controllable.

The final criterion in judging studio lighting cannot be gaged by the appearance of the picture on the home receiver alone. The influence of several factors which have a cumulative effect must also be taken into consideration. These include the nonlinearity of the system, amplitude distortion from repeater links, the broadcast transmitter and the home receiver itself. Practical experience has shown that the more rigorous control and adjustment of a monitor kinescope in the television control booth is much more useful and precise in controlling studio lighting to produce a signal capable of good reproduction on the average home receiver. Figure 8 illustrates a test pattern photographed on a studio control monitor, and in Fig. 9 the same image is shown as it appeared on a well-adjusted home receiver of a member of the engineering staff.

In a cooperative effort, the full appreciation of the experience and knowledge acquired of the television studio lighting methods and limitations can lead to a consistently improved television picture of high technical standards and artistic effort. The best results can be obtained only through the use of imagination, originality and thorough planning in applying sound fundamental principles.

The author is grateful to the many who were associated with the design and installation of the most recently completed studios and who supplied specific information. Particular thanks are extended to F. R. Rojas of the Audio Video Facilities Group and to A. W. Protzman of NBC's Television Operations for their assistance and contributions. The entire program of improving the present lighting systems and preparing for future development is continuing under the direction of O. B. Hanson, NBC Vice-President and Chief Engineer.

Electrical Printing

By JOHN G. FRAYNE

Westrex Corp., Hollywood, Calif.

SUMMARY: This paper reviews deficiencies in present photographic printing techniques of 35- and 16-mm films and shows how they are overcome in electrical printing as defined in the paper. The technique for electrical transfer of variable-density and area tracks to reversible color films is described. For transfer to black-and-white release films both the direct-positive variable-area and supersonic "toe" density techniques are compared for this type of recording service.

THERE IS MUCH INTEREST in the motion picture and television industries on the subject of electrical printing. We shall define this as the production of sound prints by recording from a master sound print, either photographic or magnetic, onto the composite release print. The action would, of course, be printed by the customary photographic methods.

It may well be asked why electrical printing should be substituted for the more customary contact printing of sound prints. The newer technique must inevitably be more complex and costly since the principal elements of precision sound reproducing and recording systems must be incorporated into an electric printer. This is to be contrasted with the primordial simplicity of the customary Bell & Howell Printer. With a specially designed electric printer, the manual operations could probably be reduced to those customary in the photographic printer, but until such printers are generally available the electrical printing process must necessarily be more expensive and slower than the standard photographic printing procedure.

The reasons for electrical printing must be sought beyond the economic factors involved. Improved quality can be the only sound basis on which a comparison of the two methods can be justly compared. To understand this phase of the problem, it is well to review briefly the difficulties presented in photographic contact printing. In the 35-mm field a sound contact print is customarily made by wrapping the negative sound film and the printing raw-stock film with emulsions in contact around a sprocket wheel. The sprocket employed in the Bell & Howell Models D and E consists of two hubs each having 64 teeth. The hollowed-out center area of the sprocket permits the passage of the light beam from the printing lamp through the rear of the sprocket and through an appropriate stationary

Presented: October 18, 1950, at the SMPTE Convention in Lake Placid, N.Y.

aperture, finally reaching the positive emulsion through the sound-track negative. In 16-mm printing the same principles are employed, the only essential difference being the use of a sprocket wheel having twenty 16-mm type sprocket teeth. The linear speed in printing varies over wide ranges to as high as 180 ft/min for 35-mm film.

Since the positive film lies outside the negative, it must of necessity ride higher on the printing sprocket teeth. If we assume for the moment that the sprocket-hole pitch of the two films is identical, they will present an uneven match to the sprocket-tooth pitch. Thus, if the pitch of the developed negative should be a perfect fit to the sprocket teeth the same pitch on the positive would in this case be underpitched as compared to the sprocket teeth. This, as is evident from Fig. 1-A, would result in the positive film being driven only by

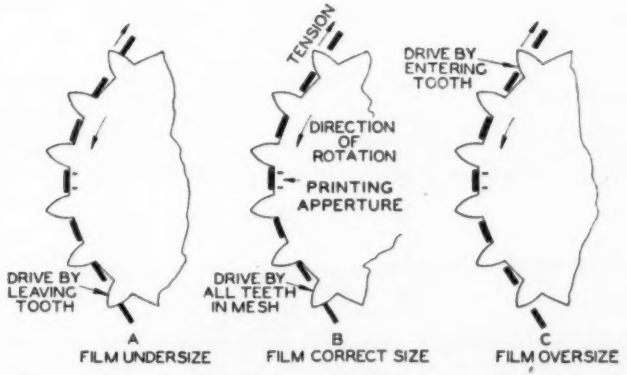


Fig. 1. Effect of film pitch on sprocket-tooth propulsion of film.

the leaving tooth. On the other hand, if the pitch of the positive film is a perfect match for the sprocket teeth, then an equally pitched negative will be overpitched with regard to the sprocket. This results in the negative film being driven by the entering tooth as indicated in Fig. 1-C. In both cases discussed above, the films, negative in the first, positive in the second, are perfectly matched to the teeth and the film is driven by all the meshed teeth as in Fig. 1-B.

In both these instances slippage of one film surface against the other takes place upon disengagement of the driving sprocket tooth. This results in (a) a velocity or flutter disturbance at the sprocket-hole frequency (96 cycles for 35-mm, 24 cycles for 16-mm), and (b) an amplitude modulation of the signal at these respective rates. The latter effect has been studied in great detail by Crabtree.[1]

Some of the amplitude modulation effects produced in a 9000-cycle tone in 35-mm film printed on a contact printer are shown in Fig. 2 for various pitch differentials between negative and positive films. This figure shows that for a nominal positive film pitch of 0.1870 in. the amplitude modulation of a 9000-cycle tone becomes progressively better as the negative goes from an overpitch value of 0.18715 in. to a subpitch value of 0.1866 in. becoming more pronounced again at a pitch of 0.1864 in. The effect on the steady amplitude of a 9000-cycle

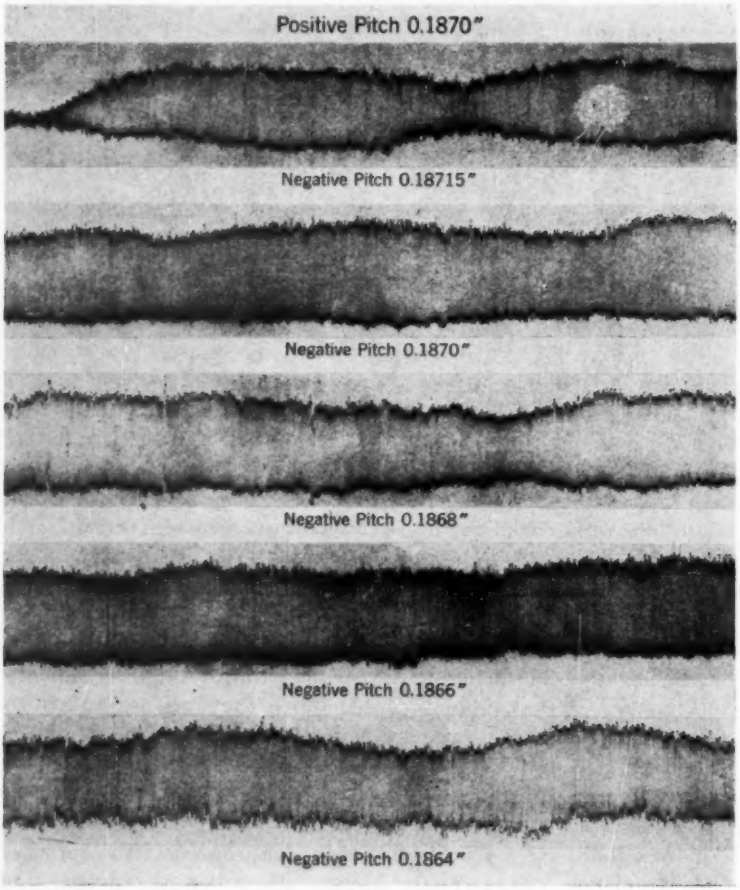


Fig. 2. Amplitude modulation effects for various pitch differentials between negative and positive films.

tone is shown in Fig. 3. This shows that the maximum print response (minimum printing loss) occurs for a pitch differential of 0.0004 in. irrespective of the type of sprocket-hole film perforations employed.

The situation with respect to 16-mm film is much worse than that indicated by Crabtree who obtained his data from 35-mm film running at 18 in./sec. The effects he found at 9000 cycles would exist at

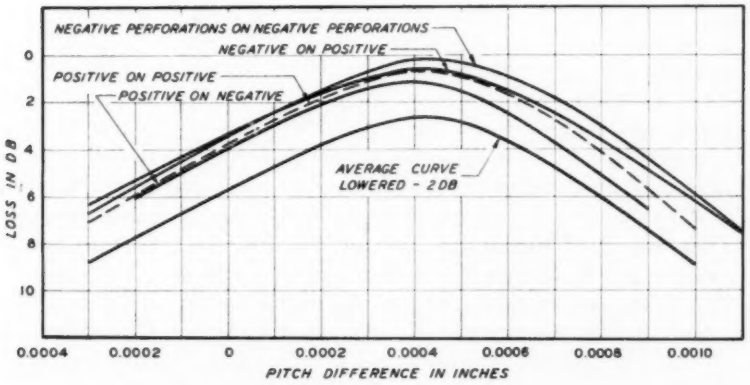


Fig. 3. High-frequency response for various pitch differentials between negative and positive films.

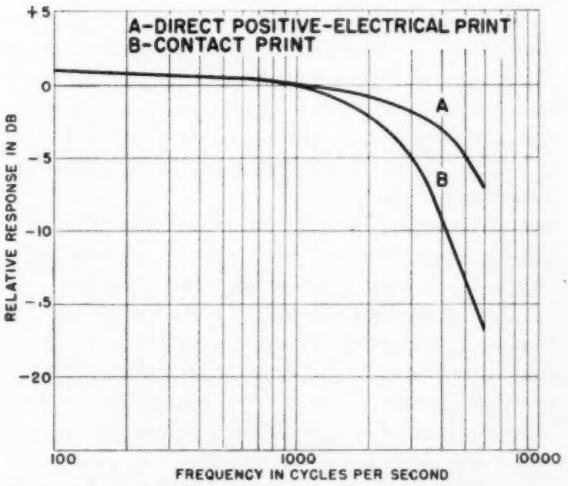


Fig. 4. High-frequency response from 16-mm direct-positive electrical print and contact print.

3600 cycles on 16-mm. The impairment of quality in the 5000–6000-cycle region in 16-mm would be comparable to that for 12000–15000 cycles in 35-mm. In view of Crabtree's findings for 9000 cycles (2-mil wavelength), it is not difficult to appreciate the greater deterioration in quality at the higher frequency or shorter wavelength. This is borne out by the steady-state frequency losses in 16-mm printing as depicted in Fig. 4 for a typical 16-mm contact print. In the same figure is shown the frequency response of a direct-positive (electrical print) in which the contact printing process is eliminated. In each film the various frequencies from 50 to 6000 cycles were recorded at constant modulation of the same light-valve modulator.[2] The net printing loss at 5000 cycles is about 8 db.

In addition to these data affecting high-frequency response, even more deleterious effects on sound quality are found in the uneven relative velocity of the films as they pass over the scanning sprocket. These appear in 35-mm film as severe 96- and 192-cycle flutter components, and in 16-mm film mainly as 24- and 48-cycle components. Thus, although a negative may have a flutter content as low as 0.1%, a contact print made from this negative may have a flutter content of 0.25% or higher. Flutter at these rates adds a fuzziness to pure tones and is particularly noticeable on the higher frequencies.

Experience to date indicates that the degradation of quality is more serious in 16-mm printers than in 35-mm. This is partly due to more progressive measures taken to improve 35-mm printers. These include the use of air pressure to maintain better contact between films and the elimination of one set of teeth on the printer associated with the use of high tension in the films as they pass by the printing aperture. The use of subpitch sound negatives especially with new nonshrinking safety-base films tends to reduce the effects noted above. When these films come into universal use contact printing may lose some of its present disfavor.

The idea of recording directly onto the composite sound picture release film has been discussed for a number of years but it is only recently that it has been given serious consideration. It must be realized at the outset that the use of electrical printing means the substitution of re-recording techniques in place of the customary photographic printing and that each "print" means the repetition of the re-recording process. This has the immediate advantage of the lower flutter content of a high-grade film-pulling mechanism over that found in commercial contact printers. In practice it means a reduction from flutter values of at least 0.25% to values not exceeding 0.1% and with corresponding improvements in sporadic amplitude

modulation. Along with improved flutter performance, an immediate improvement is found in high-frequency response. As was pointed out previously, this improvement is particularly noticeable in 16-mm recording.

Color Films

The field in which electrical printing appears to offer the most immediate advantages is in reversible 16-mm color films such as Kodachrome or Ansco Color. The practice most widely employed today with these films is to make an original direct-positive variable-area track and then print this directly onto the color film. This involves only one printing operation and is much to be preferred over the negative-positive black-and-white master which involves two printing operations with their attendant distortions. With the adoption of electrical printing from a magnetic-track master film, no printing processes would be involved and therefore all the effects, flutter and high-frequency losses would be minimized.

It can be shown that outstanding improvement is made, for example, in making a variable-density track by electrical printing on Kodachrome. In transferring variable-density to Kodachrome, the normal practice consists of (a) recording a variable-density negative, (b) making a variable-density print, and (c) printing this onto the Kodachrome. This process usually results in a sharp increase in intermodulation distortion as shown in Fig. 5 where curves for an original black-and-white variable-density print and the Kodachrome transfer are given. A further difficulty is the loss of modulation level in the transfer. This cannot be accounted for alone by the high photocell density of the Kodachrome, indicating a loss of over-all gamma or contrast in the Kodachrome reversal processing. Attempts, however, to correct this situation by resorting to a higher gamma on the black-and-white result in a further increase in intermodulation distortion.

When resort is made to electrical printing directly on Kodachrome or Ansco Color, the intermodulation distortion versus track density relationships are as shown in Fig. 6. While the minimum of about 20% compares roughly with that found in the other process, the abnormal modulation loss has disappeared and the output bears a direct relationship to the photocell track density. Also the deleterious effect of slippage resulting from the second printing operation is now missing with resultant over-all improvement in sound quality. The high-frequency response is also considerably improved.

A more limited experience with producing a variable-area track on

Kodachrome by the electrical printing method indicates that the results are not as satisfactory as with variable density. The so-called "balance" density occurs at a "clear" track visual density of about 0.7. This abnormally high clear track density results in (a) a low output from the film and (b) a high noise level. It is also found that the high-frequency response is very poor, being about 5 db less at 5000 cycles than in a comparable variable-density track. Further, an impractical value of recording lamp current is required to produce a reversal density of 0.7. As a result of these considerations, the use of variable-area electrical printing technique on reversal color films has not progressed very far to date.

The most marked improvement in making an electrical transfer to Kodachrome is obtained when the original track is either a direct-positive variable-area or a magnetic recording. In this case no printing process whatever is employed so that the maximum quality can be expected. This is especially evident in the transfer from magnetic recording since in this case the higher signal-to-noise ratio on the original track and the absence of the customary photographic-bias background disturbances make the magnetic medium an ideal one for the transfer. Either of these films (photographic or magnetic) may be 35-mm originals, thus giving better opportunity for obtaining a wider frequency response than if 16-mm originals were used.*

Black-and-White Films

For black-and-white tracks the transfer must be necessarily a direct-positive recording since the transfer must be made to the positive film on which the picture negative is also printed by the customary photographic means. If the sound track is of the variable-area type, the recording technique is well established. Thus, if the galvanometer type of modulator is employed, the method described by Dimmick[3] is directly applicable. This method uses a d-c bias type of noise reduction but differs from the ordinary negative-positive process in that the noise-reduction envelope is recorded in advance of the signal. This anticipation method of recording the bias envelope offsets the normal time delay of the noise-reduction filter and eliminates the clipping of initial modulation peaks on steep wavefront signals.

The variable-area direct-positive method is ideal for recording on a fine-grain high-contrast emulsion such as EK-5372. In this film a

* A demonstration film shown at the conclusion of this paper was an example of an electrical transfer from a magnetic original to a reversal variable-density color print. The film demonstrated the good quality that can be obtained with this method.

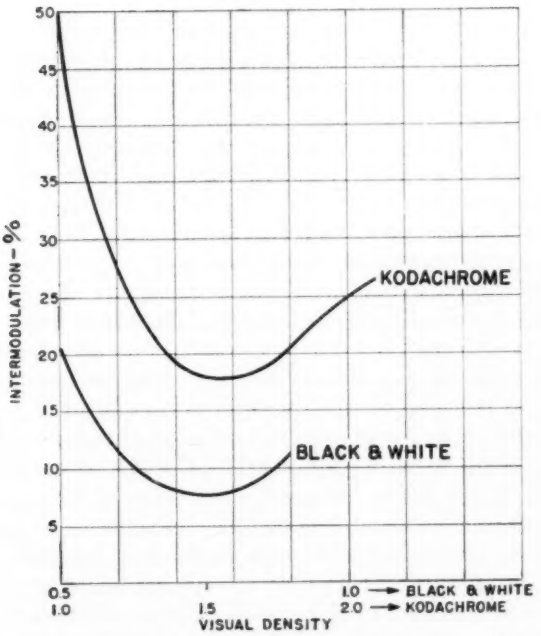


Fig. 5. Intermodulation characteristics for contact prints on black-and-white and Kodachrome 16-mm films.

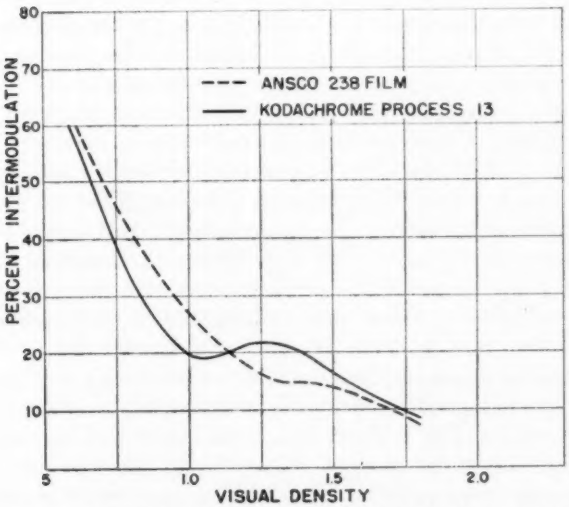


Fig. 6. Intermodulation characteristics for electrical printing on Kodachrome and Ansco Color films.

balance density including the gray base of 1.3–1.4 may be attained in a direct-positive recording.[4] Although this is somewhat lower than the silver density values normally used on release prints, a satisfactory signal-to-noise ratio may be obtained. However, in making a direct-positive transfer to a release-type emulsion like EK-7302 or Du Pont 225, the grain noise is considerably increased over the normal negative-positive process. As shown in Fig. 7 the balance density in this case on EK-7302 is around 0.5. This low density results in a considerable increase in grain noise over that in a normal variable-area print with an opaque silver density of about 1.40. The low balance density also affects the actual amount of noise reduction that may be realized. Thus, in a normal variable-area track we may consider the opaque area as contributing a negligible amount of noise. However, in the case of the low-density direct positive, the grain noise contributed by the gray area is actually increased for the biased condition. Thus, for a negligible bias-line width of say 2 mils, the grain noise is effectively increased by 3 db over the unmodulated unbiased condition. Thus, if grain noise were the only noise factor, the use of d-c bias would accentuate rather than attenuate it. The clear area is, of course, reduced in the biasing action and the noise from dirt and scratches in this area is reduced accordingly. At the same time, dirt and scratches will cause noise to be produced in the gray area. A further difficulty is the fact that the signal level is reduced by approximately 2.5 db when the "opaque" area is reduced in density from the normal 1.4 to 0.6. The net result of these factors is to effect a serious limitation in the signal-to-noise ratio of a direct-positive variable-area print on release-type emulsions.

In order to overcome this difficulty, it has been proposed that in the case where an electrical print is made from an original variable-area direct positive the latter be purposely overexposed in a manner analogous to that of overexposing a variable-area negative for printing to a variable-area positive. To do this effectively it would probably be necessary to reproduce with high fidelity the resulting distorted cycloidal wave shape of the original track and then record with equally high fidelity these same components on the transfer print which in this case is itself distorted photographically. With the frequency limitations imposed on 16-mm reproducing and recording, it is obviously impossible to do this as completely as desired. However, reference to Fig. 8 shows that some measure of success of balancing out distortions may be obtained. In this case the original variable-area direct-positive x-modulation tests were recorded for densities varying from about 0.8 to 2.2, using EK-5372 type emulsion.

These were transferred electrically to EK-7302 type emulsion and the resulting x-modulation products measured for print densities varying from about .70 to 1.20. Figure 8 shows the cancellation of the unwanted 400 cycles in db plotted against negative density for four print densities. It will be noted that there is a definite shift toward higher optimum negative densities with increasing print densities

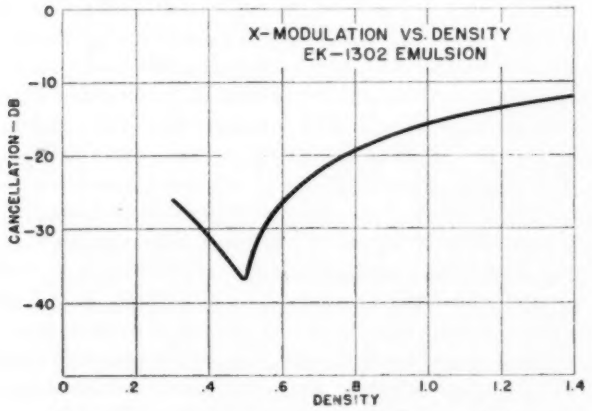


Fig. 7. Cross-modulation for EK-7302 direct-positive.

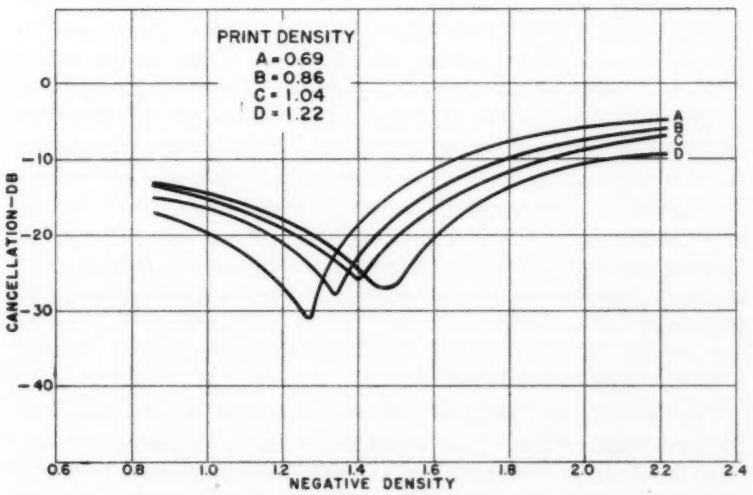


Fig. 8. Typical family of cross-modulation curves for various electrical print densities.

with only a relatively small increase in x-modulation distortion. Thus, for these film combinations (EK-5372 and EK-7302) it is possible to use a print density as high as 1.20 from a corresponding negative density of 1.5. This arrangement results in a marked decrease in print grain noise (about 10 db) with only a minor increase in x-modulation. In making this transfer the input to the electric printer was essentially flat to about 6500 cycles, the losses on the original film being compensated for by electrical equalization. It should be noted here that this result is based on a given set of developing conditions and the use of certain emulsions. It has not been established that similar results can be obtained under the wide variations of film processing inevitably encountered in the industry.

Another method of obtaining a higher electrical print density is the use of a predistorting amplifier in the transfer process to compensate for the distortion resulting from the use of higher than the balance density. In this case the original (direct-positive or magnetic track) would be a normal low-distortion recording. The distorting amplifier would then insert distortion products which result in an out-of-phase cancellation of the normal film distortion. Since the distortion products attributable to fill-in are normally even-order harmonics, a similar complementary distortion would of necessity have to be introduced in the transfer circuit. This indicates the introduction of a certain amount of controlled rectification in the transmission circuit. In the case of a relatively high-impedance modulator, such as a galvanometer, insertion of the latter directly in the plate circuit of the driving-amplifier tube would readily permit the introduction of this type of distortion. If the driving amplifier is operated on a nonlinear portion of the output-tube characteristic and the galvanometer is properly "poled" in the circuit, it is at least theoretically possible not only to cancel out the original overexposed film distortion components but at the same time correct for the "zero" shift by virtue of the changing plate current. The writer understands that this method of compensation has been tried out with moderate success but he has had no personal experience with the technique.

Variable-Density Direct-Positive

The recording of a black-and-white variable-density direct-positive presents some difficult photographic problems. It is well known[5] that the ordinary straight-line variable-density negative is highly distorted and cannot be reproduced directly except through a specially designed amplifier.[6] However, the use of the "toe" region of the

positive H&D curve when the gamma is sufficiently high offers reasonable linearity over a portion of the curve. Toe recording has been practiced since the earliest days of sound recording using both direct reproduction from the negative as well as from a toe print made from the former.[7] Reasonably high quality can be obtained from toe reproduction as long as d-c biasing is not employed. The use of the latter results in operation into the more curved region of the film characteristic which introduces considerable distortion in the lower level sounds and results in undesirable volume expansion of higher level signals. Also the use of a d-c bias with a toe negative reverses the normal transmission-exposure relationship and results in a higher noise level for low-level signals. This situation can be rectified by reversal of the bias current by which the modulating light-valve ribbons are biased open for low-level operation, returning to the normal spacing for the higher-level input. While this technique results in normal noise reduction in the reproduced signal, it, of course, precludes the use of reverse bias. Also the difficulties attendant on the use of toe recording and referred to previously are, of course, still present.

Recently a very novel method of obtaining a variable-density direct positive with a minimum distortion has been described in the JOURNAL.[8] In this method a supersonic bias is superposed on the modulating light-valve ribbons along with the ordinary signal currents. The supersonic bias is applied at a constant amplitude and at sufficiently high frequency so that, for 16-mm at least, it is not recorded on the film to any appreciable extent and is not reproduced in the normal reproducing process. It has been found that a 24-kc bias is satisfactory for 16-mm. The use of any higher bias frequency results in spurious modes of ribbon vibration. The purpose is to convert the light transmitted by the normal modulation of the valve to a wave shape which when combined with the toe photographic characteristic gives a nearly linear relationship between signal light-valve current and the projected film transmission. It has been found that good linearity is obtained when the peak amplitude of the bias current gives about 200% modulation of the ribbons. When normal signal currents are applied they have the effect of shifting the mid-point of the bias oscillation. With the use of 200% bias the valve is more than closed for at least a portion of each bias cycle, this being made possible by the passage of the biplanar ribbons past each other.

The manner in which the supersonic bias works is best understood by reference to Fig. 9. Without the bias, the light transmitted through the valve is directly proportional to the ribbon opening as

shown by line OB. Also without the bias, no light is transmitted for any closed positions of the ribbons such as OA. With the bias applied, the ribbon opening undergoes a sine-wave variation corresponding to the bias peak amplitude. When the signal amplitude is greater (in the opening direction) than that of the bias as at E, the average value of the transmitted light is not changed. However, for instantaneous signal amplitudes such as between D and E the valve is closed during a portion of the bias cycle and the transmitted light

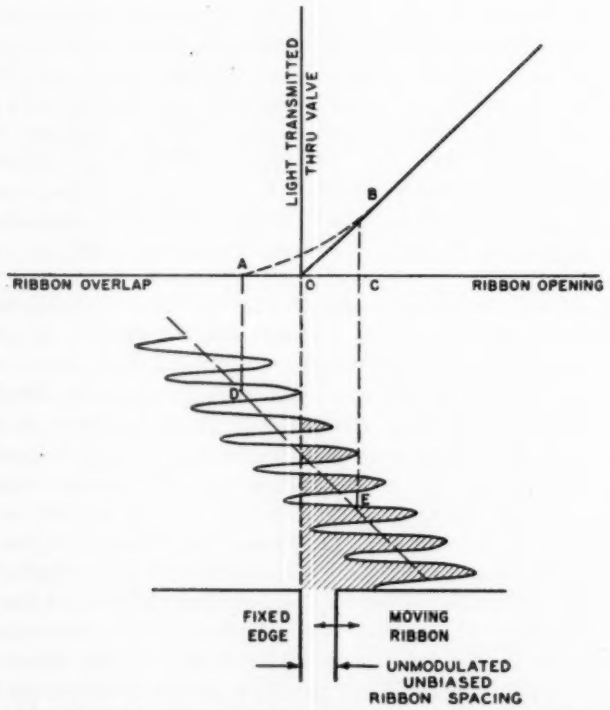


Fig. 9. Change in exposure produced during recording with a-c bias.

is in the form of a series of supersonic pulses as shown in the shaded portion of the figure. For signal amplitudes of negative polarity, such as at D, the valve remains completely closed at all times. This point represents the overload condition of the supersonic valve. For signal amplitudes lying between D and E, the average transmitted light lies along the curve AB. This represents the effective exposure of the film and this combined with the normal "toe" transmission

characteristic of the film gives an improved linear relationship between film transmission and input signal current.

The improvement in linearity is substantiated by the use of an intermodulation test.[9] Figure 10 shows intermodulation distortion for a normal toe recording and one made with supersonic bias. It will be noted that the distortion drops from a low of about 25% to a minimum of about 4% when the bias is applied. The latter occurs at a projected transmission of about 58%. This means that a very "light" sound track results which is subject to extraneous noise from scratches and dirt. The grain noise is, however, reasonably low due to operation near the 50% film transmission value which normally gives the maximum signal-to-noise ratio for a variable-density track. However, without the use of a superposed d-c bias the grain noise is somewhat excessive.

It is possible to use a combined d-c and a-c bias and obtain further noise reduction. In fact, this technique is being currently used in a

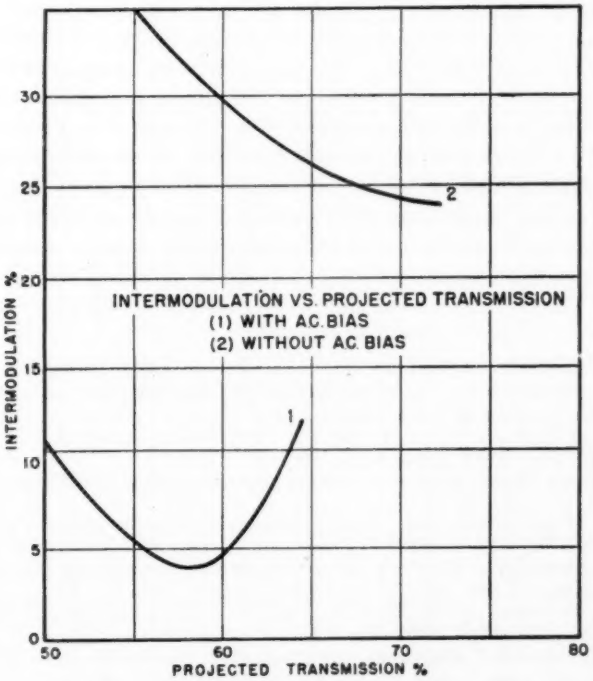


Fig. 10. Intermodulation vs. projected transmission with and without a-c bias.

Hollywood 16-mm studio where it is reported that an effective 4 db of noise reduction is obtained. It is difficult to obtain more than this amount without serious distortion of low-level signals and also volume expansion, as is obvious from reference to the curving characteristic of Fig. 9 for lower film-transmission values.

Summary

The difficulties hitherto inherent in contact printing of sound tracks, particularly with 16-mm films, have increased interest in what is coming to be known as electrical printing. In this process the release sound track is recorded directly on the composite print. This method obviates the difficulties inherent in contact printing and permits correction of sound level and frequency equalization in the transfer process. Electrical printing may be done on reversible color films by recording standard negative sound track with standard d-c bias. For electrical printing on black-and-white positive emulsions, either a direct-positive variable-area or a direct-positive variable-density print may be made. With the former, a d-c type of bias can be employed to enhance the volume range. With the latter, the use of a supersonic bias eliminates the distortion otherwise found in "toe" variable-density positives. The high average transmission of films made with the latter method assures not only a high output but also a fairly good signal-to-noise ratio. The addition of a d-c bias adds still further to the permissible volume range. In all electrical printing techniques, the resulting prints show improved flutter performance, have better steady-state high-frequency response and have considerably less amplitude modulation of the higher frequencies.

REFERENCES

1. J. Crabtree, "Sound film printing," *Jour. SMPE*, vol. 22, p. 98, Feb. 1934.
2. L. B. Browder, "Direct-positive variable-area recording with the light valve," *Jour. SMPE*, vol. 53, p. 149, Aug. 1949.
3. G. L. Dimmick and A. C. Blaney, "A direct-positive system of sound recording," *Jour. SMPE*, vol. 33, p. 479, Nov. 1939.
4. D. O'Dea, "Comparison of variable-area sound recording films," *Jour. SMPE*, vol. 45, p. 1, July 1945.
5. John G. Frayne and Halley Wolfe, *Elements of Sound Recording*, p. 275, John Wiley, New York, 1949.
6. W. J. Albersheim, "Device for direct reproduction from variable-density sound negatives," *Jour. SMPE*, vol. 29, p. 274, Sept. 1937.
7. John G. Frayne and Halley Wolfe, *Elements of Sound Recording*, p. 288, John Wiley, New York, 1949.
8. C. R. Keith and V. Pagliarulo, "Direct-positive variable-density recording with the light valve," *Jour. SMPE*, vol. 52, p. 690, June 1949.
9. J. G. Frayne and R. R. Scoville, "Analysis and measurement of distortion in variable-density recording," *Jour. SMPE*, vol. 32, p. 648, June 1939.

Motion Picture Studio Use Of Magnetic Recording

By LOREN L. RYDER

Paramount Pictures, Inc., Hollywood, Calif.

SUMMARY: Experience to date indicates that magnetic recording can improve quality, simplify operation and reduce cost in motion picture making. Further, the extent to which these objectives are accomplished is largely dependent upon the willingness to change technique and equipment.

Through the years the motion picture industry has evolved a very satisfactory but complex system of handling, and recording on, photographic film. Most of the quality improvements have required modifications and additions to existing equipment, complicating rather than simplifying the system. The conversion to magnetic recording is the first large step toward simplification in twenty years. It involves enough advantageous changes to justify this reconsideration of the entire procedure.

If we define an ideal magnetic recording system, the definition would call for all of the mechanical procedures to be automatic, all manual operation to be simple and foolproof, all magnetic film to be available for re-use, production equipment to be light in weight and the release quality to retain the quality heard at the microphone. We can come surprisingly close to accomplishing these objectives. The Paramount West Coast Studio and Ryder 16 MM Services, Inc., are now using the methods and equipment described in this paper.

The over-all procedure involves a suitcase production recording channel using 17½-mm magnetic film, a system of transferring the print takes to direct-positive photographic film for editing and an edge numbering device for identifying and synchronizing all film. 35-Mm magnetic film is used for all dubbing and scoring. The transferring during picture finishing is largely from magnetic to magnetic.

The production recording channel is in effect a sound storage unit. Except for microphone placement and mixing, it is completely automatic and requires no attention. The complete channel, including mixer unit, power unit and recording machine, loaded ready for use, weighs less than 100 lb. Figure 1 is a picture of the complete production recording channel.

Presented: April 24, 1950, at the SMPTE Convention in Chicago.

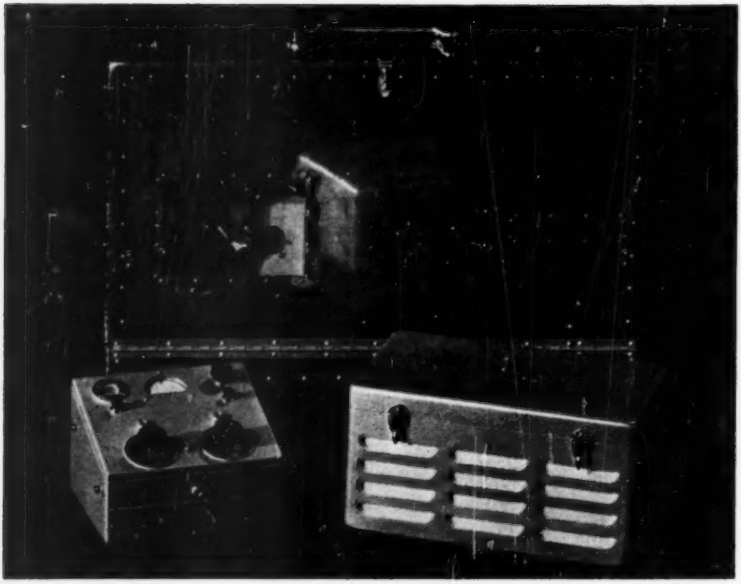


Fig. 1. Complete channel

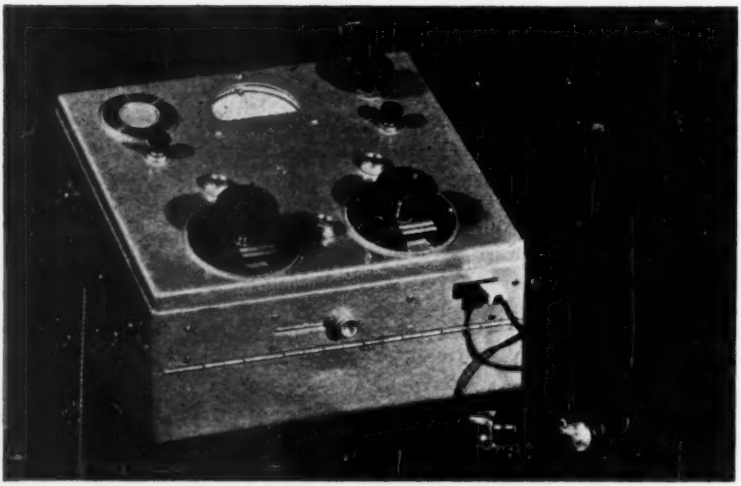


Fig. 2. Mixer, including recording amplifier.

All recording amplification, including the preamplification, is enclosed in the mixer unit, Figs. 2 and 3. The input to the two dials accommodates either dynamic or ribbon microphones. The mixer unit output is fed through the power unit to the recording machine. Playback monitoring is available to the mixer by pressing a button. The mixer unit also includes an announce microphone with control button, a dialog or music equalization control, and a rotary control switch. The switch positions are: "off," "A supply on," "A and B supply on" with normal volume indicator setting, "A and B supply on" with 6-db attenuation in the volume indicator circuit, "A voltage" measurement on the volume indicator meter and "B voltage" measurement on the volume indicator meter. A special feature of this mixer unit is that two such units can be clipped together to form a four-dial mixer.

The power supply is from dry batteries when shooting on location and from a power unit for studio use. The power supply is plugged into the cable between the mixer unit and recorder, thus reducing the number of cables to the mixer unit. Tap switches are located in the battery box for maintaining proper voltage as measured at the mixer unit. A set of batteries lasts four to six days of production shooting.

The recording machine, Fig. 4, uses the Alexis Badmaieff two-flywheel system of film stabilization and movement. This provides low flutter and extremely good contact as the film complies with the recording and playback heads. The recorder case also includes the bias oscillator, pre-equalizer and playback amplifier, all powered and under the control switch of the mixer. The playback amplifier filament supply is wired through the playback control switch so that the filaments are only fired up when the mixer is listening to playback monitoring. The recording machine is driven by a $\frac{1}{50}$-hp synchronous motor, either 100-v, a-c, single phase, or 220-v, three phase. At Paramount 220-v, three-phase motors are used. For studio operation the recording machine gains its motor power in return wires from the camera. Under this arrangement the recording machine starts and stops under the control of the cameraman. The camera is synchronously driven from the 220-v, three-phase studio supply. D-c–a-c or multi-duty type motors are used on the cameras when shooting on location. The a-c windings from the motor, which are normally used for interlocking, are in this case used as a power supply for driving the recorder. On location, the same as at the studio, the equipment is started and stopped by the cameraman. A special camera motor which the writer is having built includes an automatic speed control built into the handwheel of the camera motor. The recording

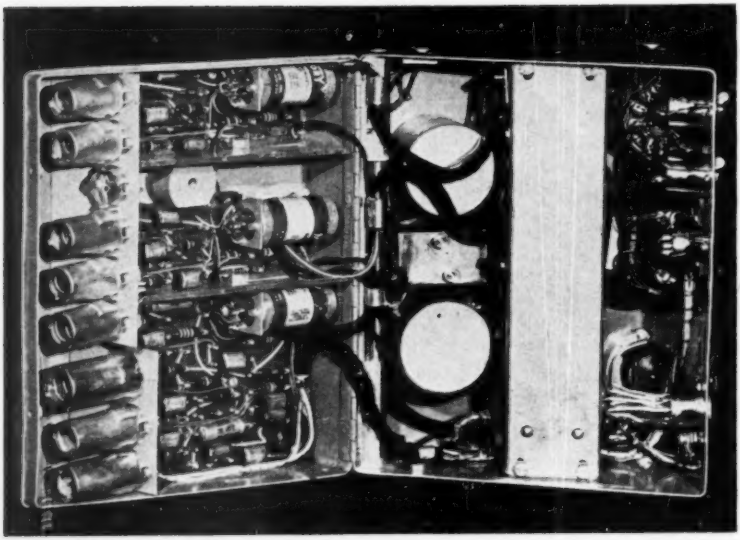


Fig. 3. Interior view of mixer.

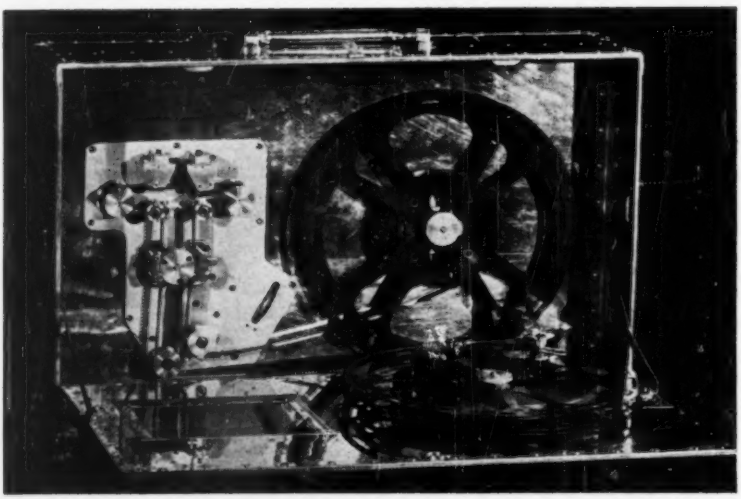


Fig. 4. Automatic recorder.

machine loaded with 2,500 ft of magnetic film weighs less than 50 lb. The feed reel is on the hinged front cover and can be operated either open or closed. Lucite windows in the front cover permit viewing the operation or checking the available footage without opening the case. The case is made of $\frac{1}{4}$-in. balsa wood laminated with aluminum. There are no switches or operating controls either in or on the recording unit.

The plan of operation at Paramount is to service, load and unload all units at the recording plant prior to each day's work. Two complete channels are sent with each production. In operation the recording units are exchanged rather than reloaded. When shooting at the studio, the used recording unit is replaced with a freshly loaded recorder from the Recording Building. The second mixer unit supplies four dials when required. Trouble shooting on production is eliminated. The complete channel is exchanged in case of trouble or suspicion of trouble.

Synchronization can be by clapstick or, in the case of Paramount, a magnetic bloop signal is recorded on the magnetic film along with completion of automatic slating in the camera. The take numbers are announced by the mixer during the 5-sec period while the equipment is coming up to speed and stabilizing. Each roll of magnetic film is marked with the production number and given a sequential number. All rolls of magnetic film at the Paramount plant have a master punch synchronizing mark at the head end of the roll. The sound mixer's log lists all takes in sequence and indicates the roll numbers and also the printed takes. The take footage information can be obtained from the cameraman at the end of the day, if desired; however, this procedure is no longer found necessary at Paramount.

As fast as complete rolls of magnetic film are received at the Recording Building, the print takes are transferred to direct-positive photographic "electro-prints" which in turn are developed and used for editing. The transfer reproducer has the Alexis Badmaieff film movement mounted on a panel as shown in Fig. 5. This reproducer is equipped with a counter and is capable of fast winding, both forward and backward. The roll of magnetic film is threaded on this machine starting at the punch synchronization mark with the counter at zero. The operator fast winds down through the roll, monitoring and checking his log until the synchronization click for the first print take is located. The click is stopped under the reproduce head and a pencil mark is made between the sprocket holes on the magnetic surface of the film. The footage information is recorded on the log as an expedient for reprinting.

The direct-positive recording machine is equipped with a special photographic marking device that exposes the production number, the scene number, the take number and the footage at one-foot intervals along the edge of the film. The sound recording is by the supersonic direct-positive system described by C. R. Keith and V. Pagliarulo in their paper "Direct-Positive Variable-Density Recording With the Light Valve" (*Jour. SMPE*, vol. 52, pp. 690–698; June 1949). After setting the edge numbering device, the recording machine is interlocked with the transfer reproducer and turned over for the length of the take.

Paramount has also developed a 5,000-ft 35-mm magnetic recorder known as a sound storage unit. These machines operate automatically and are played in multiple with the direct-positive recorder, thus gaining a protection record of all printed takes. The 5,000-ft rolls are used on both sides and stored until the completion of the picture.

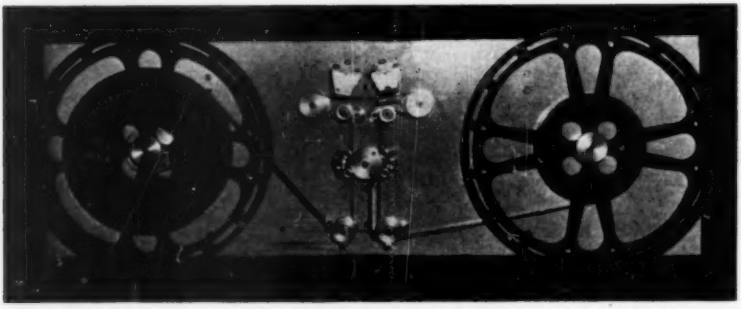


Fig. 5. 17½-Mm reproducer.

The direct-positive prints are developed, synchronized with the picture prints for daily running and then used for cutting. A special print-on numbering machine has been built to edge number the picture film with the same numbers that appear on the sound print. This makes it such that every foot of positive film in the entire plant can be identified and synchronized without further coding. All reprints carry the same numbers and, therefore, can be identified and synchronized without cross coding. It is contemplated that eventually the picture numbering will be done photographically in the camera.

Two of the Badmaieff 35-mm rack-mounted panel-type recording units are used for each scoring channel. The machines are used alternately. 1,000-Ft lengths of 35-mm film are threaded on the punch synchronization mark and fast wound down to the predeter-

mined footage for the start of music. A pencil mark is made at the edge of the film at this point for future location of the synchronization mark. While the first take is in progress the second recording machine is threaded. In case of playback the recorded film is fast rewound to the footage and edge mark, thence played back. The selected takes can go immediately from the scoring room to the dubbing room. When threaded on the punched synchronization mark they are properly synchronized and ready for dubbing. When desired the double scoring recorder can be used as a transfer machine to consolidate selected takes on fewer lengths of magnetic film. All out-take film is erased for re-use on the day following the scoring. A 5,000-ft film storage unit is bridged on each scoring channel as a protection against damage or loss of the master scoring record.

A special machine has been developed to provide a visible oscillograph-type modulated signal on the magnetic film. The writing is done with a BB ball point pen. In the procedures thus far described the modulation writer is used only when accurate checking of modulation is required for deletions in music sequences.

All library sound effects and music are to be on 35-mm magnetic film. This film will carry modulation writing for convenience in synchronization. When setting up sound effects for dubbing, the sound effects will be transferred to 1,000-ft lengths of magnetic film. The transferring will be done on a machine corresponding to the double scoring recorder, except that this machine will also have a synchronously driven picture and sound reproducer for playing and viewing the cutting print. In operating this machine it will then be possible to determine where effects are wanted, then place them on the 1,000-ft length of magnetic film by the simple procedure of transferring.

The dubbing sound prints are now obtained by the direct-positive method. At an early date the dubbing prints will be a magnetic transfer from the 17½-mm original by the procedure used in obtaining sound effects.

The dubbing recording machine is a double unit, the same as the scoring recorder. The selected takes from this recorder are transferred to a release photographic negative for release printing. At Ryder 16 MM Services, Inc., all release printing of sound is done by the direct-positive "electro-printing" method which saves the cost of a sound negative and improves the quality. A print loss is avoided by the simple expedient of avoiding printing. A similar procedure may eventually be used at Paramount. All erasing of magnetic film is done on Goodell-type noise erasers. This eraser has been found

to be more satisfactory and safer than using erasing units on the recording and reproducing machines.

At this point it might be well to mention that with the exception of the few deletions in music there is no cutting or mutilating of the magnetic film. A method is being developed to eliminate this cutting. The photographic editorial sound print is the only film cut. The writer contemplates presenting a paper at the next Society convention on editorial equipments and method.

Although this paper is not complete in every detail, almost all mechanical processes are automatic, all manual operations are simple and made foolproof by devices such as the playback monitoring and the use of sound storage units. The magnetic film is available for re-use, the production equipment is light in weight and the quality of magnetic recording is well established by demonstration and use. An effort has been made to gain a consistent and satisfactory product. The freedom from defective work has been very gratifying.

Paramount now has used magnetic equipments on eleven major productions. All productions now shooting and all future productions will be recorded on these equipments. Ryder 16 MM Services, Inc., has used this equipment in a simplified form for approximately a year in the making of television, entertainment, religious, industrial and educational 16-mm motion pictures.

One of the large measurable economies is the elimination of production sound negative and the processing of it. Other large savings include the elimination of a sound truck and the reduced footage of photographic prints, especially in scoring and dubbing. The time saving that is effected in production and picture finishing is difficult to measure. However, experience to date indicates that this saving may actually be larger than all of the other savings put together. Although the over-all savings is large, it should be pointed out that it takes time and effort to make such a change and a few steps of the procedure will prove more complex.

The writer wishes to express his appreciation to Alexis Badmaieff, Barry Eddy and the members of his staff at the Paramount Studio for their able assistance and cooperation in working out the many details of the magnetic recording system which has been described in this paper.

High-Speed Photography Of Reflection-Lighted Objects In Transonic Wind Tunnel Testing

By E. R. HINZ, C. A. MAIN, and ELINOR P. MUHL

Dept. of Aeronautical Engineering, Institute of Technology, University of Minnesota, Minneapolis, Minn.

SUMMARY: There follows a discussion of the use of the Marley High-Speed Camera in special adaptation for study of objects within the test channel of a transonic wind tunnel. Included are a description of the original camera and an outline of some changes required to adapt it for the photographing of nonluminous objects. Also given are methods used to coordinate the camera exposure time with the position of the moving object "bullet" and external lighting apparatus to produce 58 pictures at a rate of 100,000/sec.

Introduction to the Problem

In connection with a Bureau of Aeronautics research contract, it was necessary to study the behavior of bullets in the transonic wind tunnel test section. Bullets were purposely shot to pass the test sections at different orientations. It was, therefore, desired to have pictures made at speeds of approximately 100,000 frames/sec, with a minimum of 50,000 frames/sec. The test section of this transonic wind tunnel measures 16 × 16 in. The interior test section can be observed through 1-in. thick circular plate glass windows which are 17 in. in diameter. It is through the window that the camera views the subject. The subject must also be illuminated through these windows as the high-speed air precludes the use of any lighting equipment inside the channel, without making major structural changes.

In selecting a camera with which to make these photographs, the high frame speed requirements eliminated many of the better known high-speed cameras. Of those cameras which had the desired frame speed, the Marley high-speed camera, manufactured by C. F. Palmer, Ltd., of London, was the most readily available. Two of these cameras had been purchased by the U.S. Navy and one of these was supplied to the University of Minnesota, Dept. of Aeronautical Engineering, by the Bureau of Aeronautics for use in this work.

Presented: April 26, 1950, at the SMPTE Convention in Chicago. This paper is a review of the developments effected under contract with the U.S. Navy Bureau of Aeronautics.

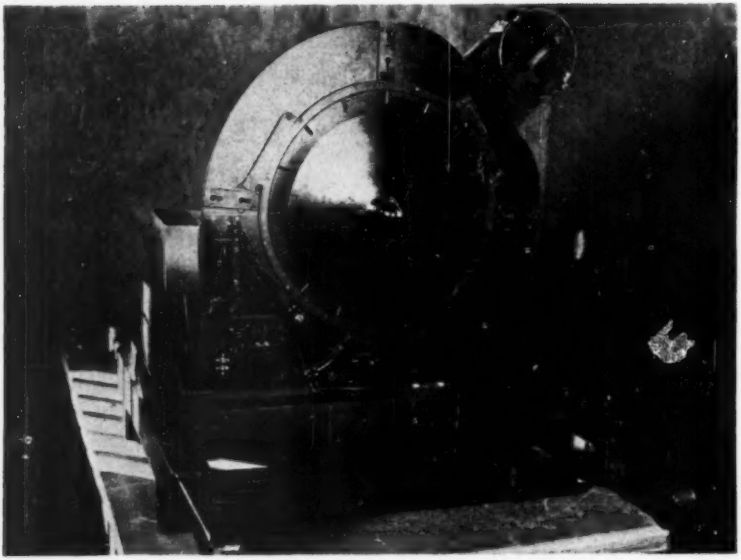


Fig. 1. Marley Camera, front view.

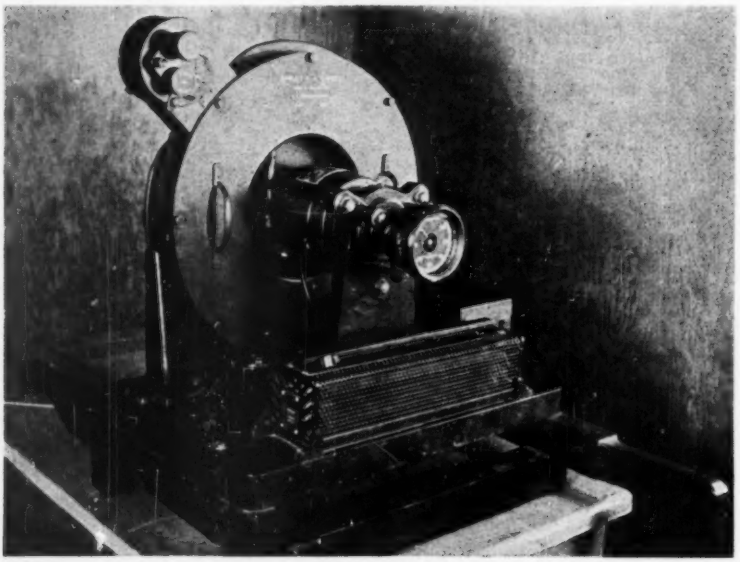


Fig. 2. Marley Camera, rear view.

The camera was originally designed to photograph explosions and other self-luminous phenomena, and it was the manufacturer's opinion that it could not be used for photographing reflection-lighted objects. Extensive development work was required to adapt the Marley camera to this sort of photography.

A brief description of the Marley high-speed camera has been published in this JOURNAL.[1] This article described the design use of the camera in recording a subject of high luminosity.

DESCRIPTION OF CAMERA

The camera consists of a set of 59 lenses arranged in a circle. Radial slots, cut in the periphery of a disc mounted to revolve in front of the lenses, expose each lens as the rotor disc rotates. Extremely high speeds of exposure are obtained by using the principle of the vernier, and providing the disc with a number of slots which is prime to the number of lenses. The camera is daylight loading and unloading and uses a 2-meter length of 35-mm perforated film, which must first be loaded into a special cassette. Views of the camera are shown in Figs. 1 and 2.

The 59 lenses are disposed round a circle of 1-ft diameter. An annular shutter ring is arranged to slide in front of the circle of lenses. This shutter ring is covered by a stationary annular cover plate with 59 narrow slots. This cover plate, with $\frac{1}{32}$-in wide slots, forms diaphragms for the lenses, which are 3.5 in. in focal length and are thus stopped down to an aperture of about $f/27$. The rotor is provided with 16 slots and is mounted directly on the shaft of an electric motor on the main frame of the camera. Behind each of the 59 lenses a small surface-aluminized mirror is placed at an angle to reflect the light radially outward onto a strip of film which lies inside the cylindrical shell of the camera body. The lenses, mirrors and film guides are shown in Fig. 3 with the camera backplate removed.

The shutter, which normally controls the period during which exposures are made, is a flat annular ring with 59 $\frac{1}{4}$-in. wide slots. By rotating it in its guides, all the lenses may be uncovered simultaneously and by rotating it farther in the same direction they may be closed again. This rotation, with the shutter in the cocked position is effected by three tangential springs located around the periphery. The shutter is controlled by the mechanism located to the left of the front plate of the camera. Details of the mechanism are shown in Fig. 4. The movement of the shutter is controlled by lever A which engages with the shutter ring by means of a rack. The shutter is cocked by pressing down this lever thus tensioning the three tangential

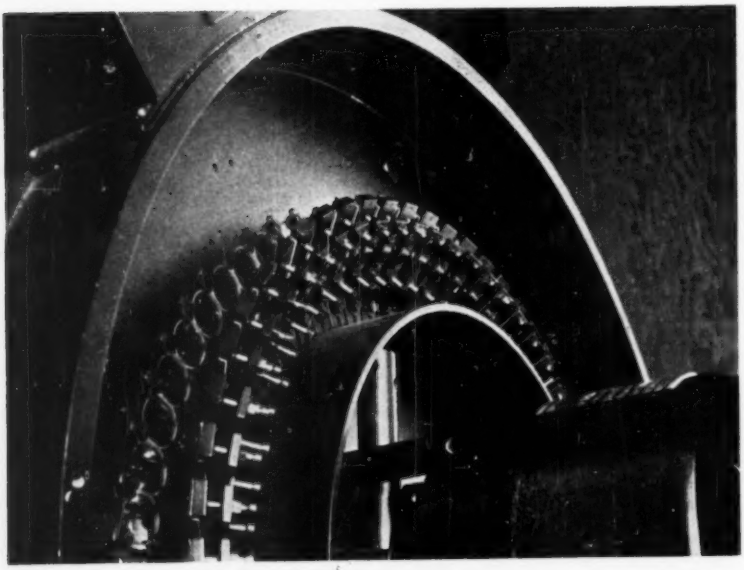


Fig. 3. View of mirror and lens system.

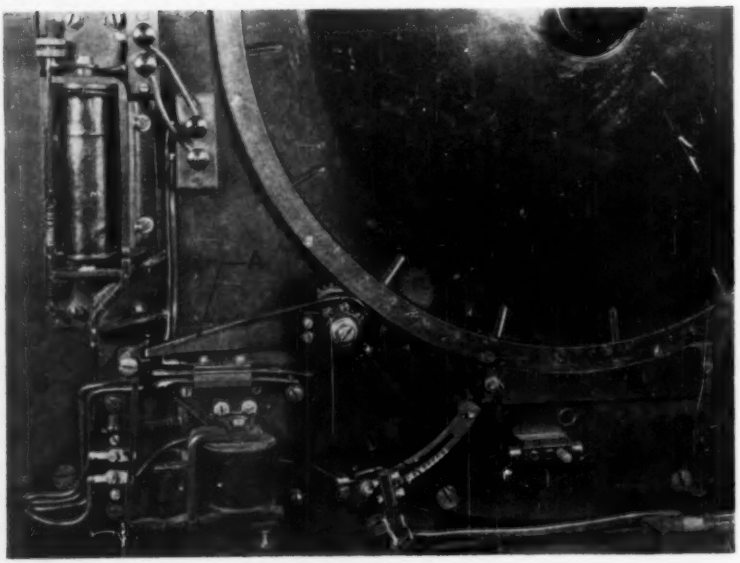


Fig. 4. Shutter mechanism.

shutter springs. Lever A is held in position by the catch on lever B. Lever B is released by energizing the associated tractive electromagnet C, whereupon the shutter rotates, uncovering the lenses for about 5 to 6 milliseconds. Adjustable firing contacts, D, are provided to initiate an electrical impulse during the short interval that lever A is in contact with them, thus providing a means for starting the action to be photographed while the shutter is open.

A shutter arresting device is provided so that the shutter may be opened before the action to be photographed takes place and closed immediately after. The shutter arrester device is shown in Fig. 5 with the shutter in the arrested position. The arresting device comprises a spring-loaded lever, C, which absorbs some of the energy of the flying shutter; the armature of the portative electromagnet B restrains the lever D, holding the shutter arm in the fully open position until the current is interrupted. The spring contacts, E, mounted below and actuated by the lug on lever A serve to energize the arresting coil, B, and break the circuit of the release coil, F, just as lever A starts to move; thus obviating undue heating of the coils which are heavily loaded. The firing contacts are held in the closed position by lever A as shown in this figure.

Rate of Exposure

The rate of exposure is governed wholly by the rotor disc speed. All 59 lenses are exposed with approximately 22.25° rotation of the rotor disc. The rotor disc is driven by a 6,000-rpm, 230-v universal motor. The speed, which can be varied by a series resistance mounted at the back of the camera, is ascertained by means of a permanently coupled tachometer. With the rotor disc turning 6,000 rpm, the rate of exposure is 95,500 frames/sec. At this rate of exposure the time required to expose all 59 frames is 618 μsec (microseconds) resulting in approximately 10.5 μsec/frame. At 4,500 rpm the exposure rate is 71,500 frames/sec or approximately 14 μsec/frame. The examples cited indicate how the speed of the rotor controls the exposure rates of the camera.

Preliminary Camera Development

Extensive development work with the Marley Camera was required to make the necessary adaptations for photographing reflection lighted objects. In the camera as supplied, the lenses were focused to give sharp definition at 22 ft. By utilizing the maximum adjustment of the aluminized mirrors in both the vertical and angular planes it was

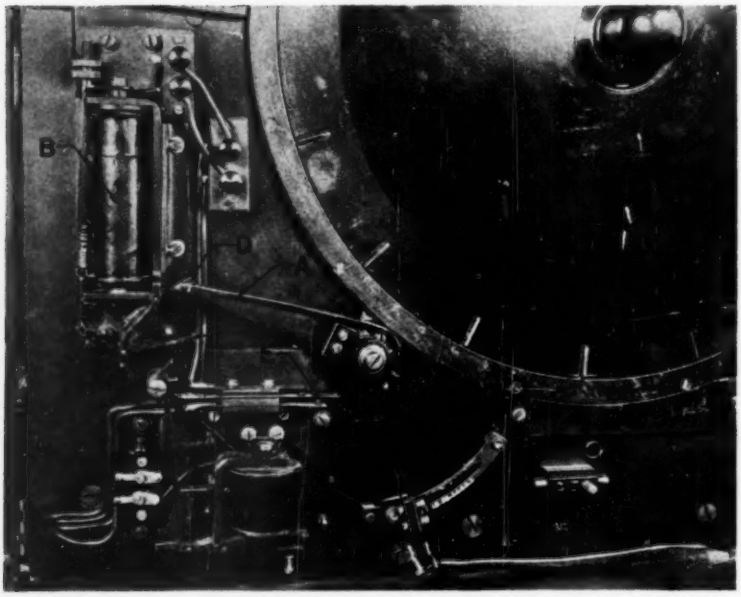


Fig. 5. Shutter in arrested position.

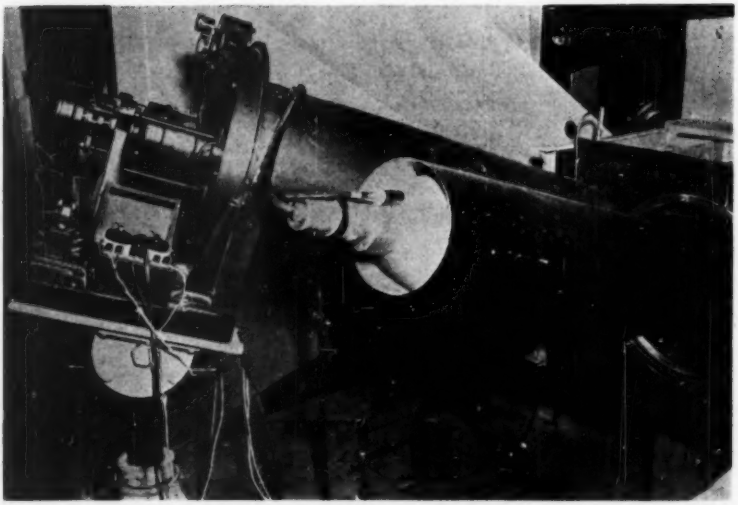


Fig. 6. Marley Camera and mount at transonic wind tunnel.

found that reasonable definition was possible at 53 in. from the object to the lens plane. The shortest distance possible was desirable due to the size of the subject and to reduce overlapping of the images as there are no dividers which clearly define each frame. Overlapping can be eliminated by using a black nonreflecting background for the areas outside the desired field. This method of controlling overlap was feasible for experimental exposures, but was not suitable for the wind tunnel situation. The reduction of overlapping on the negative was accomplished by mounting a cylindrical tube on the camera as shown in Fig. 6. This light tunnel was painted a dull black which eliminated internal reflections, decreased overlapping by limiting the field of view and reduced the interference of extraneous light.

Since the exposures were of very short duration it was desirable to have a film of maximum speed. However, this and other requirements of film and development were mutually exclusive. A good degree of contrast was needed with a minimum of grain so that the 35-mm film would result in good enlargements for analysis. The film-development combination that was finally found to be most suitable from all points of view was with Eastman Kodak Linagraph panchromatic film and D–72 (Dektol) developer in a 1:1 solution at one and one-half times recommended development time. This was found to give a good degree of contrast without objectionable grain size in a six-times enlargement.

The camera exposure sequence does not follow a simple consecutive one, two, three pattern. Also, the initial frame in the sequence is a haphazard incident, whereby the exposures may start with any one of the 59 apertures that is in coincidence with a rotor slot at the time the shutter opens or the illumination reaches an intensity sufficient for exposure. As a means of identification, the apertures were numbered in a clockwise direction with number one chosen at the twelve o'clock position when facing the camera. In viewing the film the initial exposure is first determined, then there are 48 numbers between consecutive exposures, i.e., if number 1 was the initial exposure the second in the sequence would be number 49, the third, 38, etc. Therefore, the exposure where the action under consideration starts is first determined and the sequence is followed through with the above system which is applicable regardless of the position of the initial exposure.

The stand built to support the Marley Camera for the wind tunnel tests was a modified airplane wing jack. This unit allows the camera to be raised or lowered and tilted as necessary, as shown in Fig. 6.

ILLUMINATION

The illumination problem presented a difficult obstacle in conjunction with the use of the Marley Camera. Others familiar with the camera were skeptical of the possibility of providing sufficient light to photograph nonluminous objects.

Early experiences with the camera showed that sufficient light, about 42 megalumens, could be obtained with a battery of photoflash bulbs for satisfactory exposure. However, the arrangement of an array of flash bulbs to be focused through a 17-in. diameter window and the elimination of the resulting reflections was a formidable problem. Also, the photoflash bulbs have a variable ignition time resulting in an effective flash time of 30 to 50 milliseconds. In conjunction with the duration of the flashbulbs, the period of operation of the mechanical shutter requires 5 to 6 milliseconds which would expose each frame ten times if all 16 slots of the rotor were used at 6,000 rpm. Inasmuch as the mechanical shutter operation cannot be speeded up and a high exposure rate was required, the only suitable light source was electronic flash equipment capable of controlling the duration of exposure.

A standard Strobo–IV flashtube power supply unit satisfactorily fulfilled the requirements of short duration and high output. The Strobo–IV is produced by Strobo Research, Milwaukee, Wis. It is designed for an output of 1,000 wsec (watt-seconds) and is equipped so that the energy may be divided by plug-in outlets into energy levels of 1,000, 500 and 250 wsec. General Electric flashtubes types FT-403 and FT-503 were used with the Strobo–IV power supply.

The General Electric flashtube FT-403 has a rated output of 45 megalumens at 480 wsec. Figure 7 shows the characteristic time-intensity curve of the FT-403 at 2 kv and 250 μf or 500 wsec, and of the FT-503 at 4 kv and 250 μf or 2,000 wsec from information supplied by General Electric. In common with all capacitor-flashtube light sources, the actual duration of the flash is long, compared to its photographic effectiveness, because of the relatively weak illumination produced by the tail of the time-intensity curve. Accordingly in evaluating such curves, exposure time with electrical flash can be defined as the time that the light intensity is above one-third of the peak value. The Strobo–IV power supply provides 500 wsec for the FT-403 with 2,675v and 140 μf resulting in a peak light intensity of 45 megalumens with effective light for a duration of approximately 500 μsec.

The illumination setup used for the tests consisted of the Strobo–IV

power supply unit and two FT-403 electronic flashtubes. These were disposed on opposite sides of the wind tunnel, illuminating the test section through the two plate glass windows in the walls of the wind tunnel. In another series of tests the FT-503 was used providing a peak intensity of 75 megalumens with an effective light duration of approximately 800 μsec.

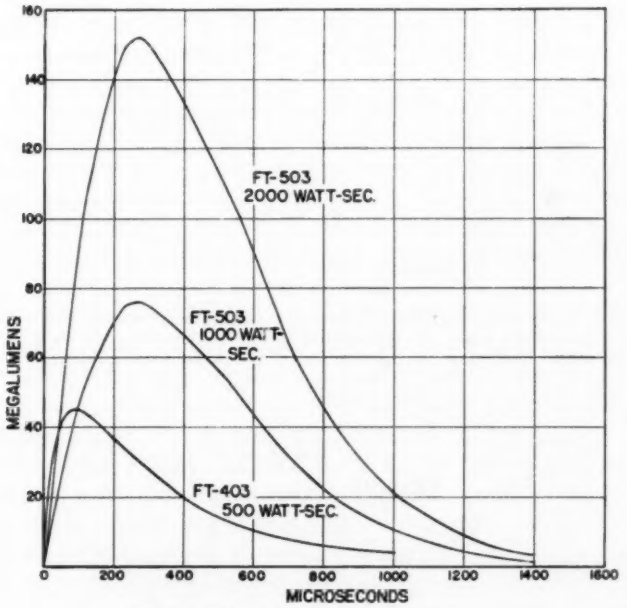


Fig. 7. Flashtube time-intensity curves.

TIMING AND ELECTRONICS

The necessity for accurate timing was imperative for complete success of the testing program. The timing problem required the elimination or restriction to a minimum of all operating variables. The adaptation of the electronic flash equipment which was reliable and consistent simplified the problem and revealed some of the other variables. The mechanical shutter was found to be erratically variable. However, the shutter arrester device provided a convenient means of eliminating this difficulty using the flash duration and rotor speed to govern the exposure time. The use of the shutter arrester device also eliminated the inherent delays of the electromag-

netic and solenoid-plunger units involved. The high-speed airflow in the wind tunnel precluded the use of microphone pickups and other timing devices placed in or near the test section. A special wire holder was mounted on the muzzle which provided a positive means of determining when the bullet was 6 in. from the muzzle. The only troublesome variable that remained was the variation in bullet velocity, and

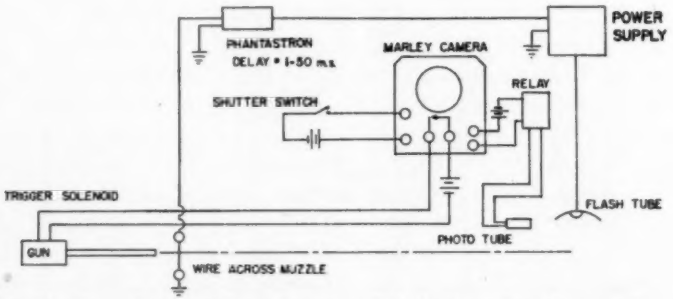


Fig. 8A. Operating diagram. *Sequence:* (1) shutter released manually; (2) camera contacts fire gun; (3) gun breaks wire, starts pulse into relay; (4) delayed pulse fires light; and (5) light on phototube closes camera shutter.

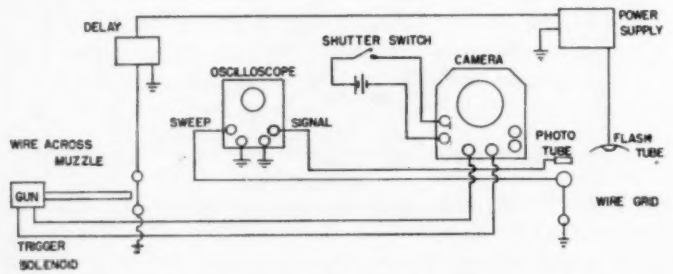


Fig. 8B. Timing calibration diagram. *Sequence:* (1) shutter released manually; (2) camera contacts fire gun; (3) gun breaks wire, starts pulse into delay; (4) bullet breaks wire grid, starts sweep; (5) delayed pulse fires light; and (6) phototube shows light pulse on screen with peak of light at beginning for correct timing.

this variation was reduced to a minimum by temperature control and careful handling.

Since the gun was located at a distance of 10 ft from the center of the test section, a delay unit was required in the circuit to compensate for the time required for the bullet travel. A phantastron delay unit was constructed with a variable control delay of .3 to 15 milliseconds

or with a change in capacity a delay of 1 to 50 milliseconds was possible.

The final complete camera, gun and flash operating circuit resulted in a series operation in which no two units required simultaneous interdependence. The components of this circuit (Fig. 8) and the sequence of operation was as follows:

1. A control panel containing a power control switch and a triggering switch initiated the sequence of events.

When triggered, the tractive electromagnet was energized from an external source of 200-v d-c power which released the shutter. The shutter was retained in the open position by the shutter arrester. The shutter arrester portative electromagnet was energized from an external 12-v battery. The adjustable contacts actuated by the shutter lever were adjusted to close when the shutter was arrested in the open position.

2. The gun was fired with a special 24-v solenoid-plunger mechanism. The solenoid was energized by a 24-v battery through the set of adjustable contacts on the Marley Camera.

3. A wire in a special holder on the muzzle was broken by the bullet 6 in. from the end of the barrel. As the wire broke, it triggered a 2D21 thyratron which imposed a negative pulse on the phantastron delay circuit. The phantastron delay unit emitted a sharp positive pulse of about 25 μsec duration at 150-v amplitude.

4. The delay pulse triggered the Strobo–IV electronic flash unit.

The triggering circuit of the unit originally consisted of an OZ4 cold cathode thyratron which supplied a pulse into an ignition-type high voltage transformer to initiate firing the flash tubes. It was necessary to modify this trigger circuit due to erratic triggering of the cold thyratron. The OZ4 was replaced by a type 2050 hot cathode thyratron. This made a marked improvement in the bad time jitter previously encountered in triggering the flashtube. It also allowed the addition of a longer cable between the delay unit and the flashtube trigger unit without appreciable difficulty in triggering due to attenuation of the sharp delay pulse.

5. The illumination emitted by the flashtubes activated a photoelectric cell and amplifier to de-energize the shutter arrester solenoid allowing the shutter to close.

The output of the photoelectric cell fired a thyratron which, through a common cathode resistor, cut off the plate current of a triode tube, de-energizing a normally closed relay in the plate circuit. The shutter arrester control circuit was manually energized to prevent overheating of the windings.

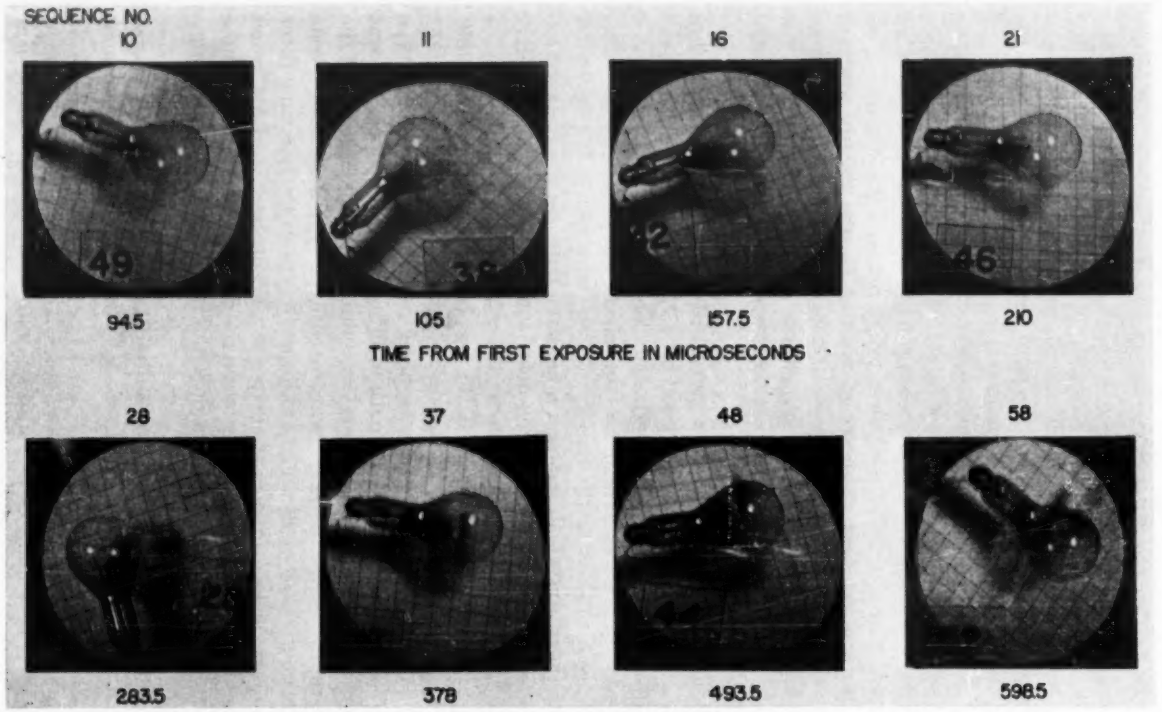


Fig. 9. Series of photographs of a .22-caliber bullet passing through an electric light bulb. Exposure rate, 95,500 frames/sec; exposure time, 10.5 μsec/frame; illumination, one General Electric FT-403 at 3 ft.

In the timing calibrations, oscilloscopes were used to show the time relationship of the flashtube output to the bullet position at the center of the test section. A wire grid assembly was placed in the center of the test section and fired into. The bullet breaking a wire in the wire grid, energized the oscilloscope single sweep. The output of a photoelectric cell placed near the electronic flashtube was fed into the vertical deflection plates so that that part of the light occurring after the grid wire broke appeared at the beginning of the sweep. Two sweep speeds were used: a 4-millisecond, for setting rough placement; and a 600-μsec, for fine adjustment of the delay setting. Consequently, by adjusting the delay circuit, the peak illumination could be controlled in relation to the bullet position. The timing and electronics problems were solved by W. Y. Fish of our electronics group and the optical problems by E. H. Wrench.

Figure 9 presents excerpts of a series of photographs of a .22-caliber bullet passing through an electric light bulb. This sequence was taken at 95,500 frames/sec with one FT-403 flashtube at a distance of 36 in. from the object. The angular orientation of the frames is due to the disposition of the lenses about a circle. Consequently, each lens views the subject from a different angle. The numbers on the individual frames are lens numbers or frame numbers previously described and do not represent the order of exposure. Unfortunately many examples of the use of this equipment are not available for showing at this time because of the type of material they are concerned with.

PROJECTED USES

In considering the possible uses to which this camera may be put in the future, it seems more appropriate to describe the conditions under which the camera could be made useful, than to suggest specific situations. Such a list would probably omit many possibilities which are not presently apparent.

Through the manipulation of the different variables, it is possible to operate this camera at speeds from about 1,000 to 96,000 frames/sec. It appears, however, that the chief advantage of this camera lies in its ability to photograph at high frame speeds, as there are a number of cameras which give good results at lower frame speeds, and do not have some of the disadvantages of this camera. At its upper range the Marley Camera is capable of photographing rapidly moving objects as they pass through a given field of view, or any rapid change taking place. It is now established that it is possible to use

this camera for photographing either selfluminous objects or objects illuminated by reflected light.

In the future, the construction of separators inside the camera is advisable, to eliminate overlapping on the film of images from adjacent lenses. In photographing selfluminous objects, for which the camera was designed, this would probably be unnecessary but would not be detrimental. For photography by reflected light it would eliminate the necessity of a black background surrounding the object and/or the use of a light tunnel or similar device for limiting the field of view. Although the light tunnel eliminated the most objectionable overlapping, there still was some present. While the pictures obtained served the purpose, it was felt after the tests were completed that the addition of separators to the camera would have made the job of analysis an easier one.

REFERENCES

1. G. A. Jones and E. D. Eyles, "Recent British equipment and technique for high-speed cinematography," *Jour. SMPE*, vol. 53, pp. 502–514, Nov. 1949; also in *High-Speed Photography*, vol. 2, pp. 76–88, Nov. 1949 (reprinted from the Nov. 1949 *Jour. SMPE*).
2. General Electric Flashtube Technical Information Bulletin, L. S. 110, Jan. 1948.
3. William, Mortensen, *Flash in Modern Photography*. 2d ed., Camera Craft Publishing Co., San Francisco, 1947.
4. Harold E., Edgerton, "Electrical-flash photography," *High-Speed Photography*, Part II of *Jour. SMPE*, vol. 52, pp. 8–23, Mar. 1949.

U.S. Naval Underwater Cinematography Techniques

By R. R. CONGER, AFC, USN

Motion Picture Dept., U.S. Naval Photographic Center, Anacostia 20, D.C.

SUMMARY: The Navy's earlier procedures in underwater cinematography are reviewed, then the progress to the latest equipment and methods used by the Naval Photographic Center. From knowledge gained on location tests, current techniques stress extreme mobility and versatility using a single cameraman. The motion picture camera and deep sea diving equipment now in use are briefly described.

DURING WORLD WAR II several training films were made under water with some success; however, water conditions under which this photography was performed were considered the most ideal. Even then it was recognized that the range of operations was limited.

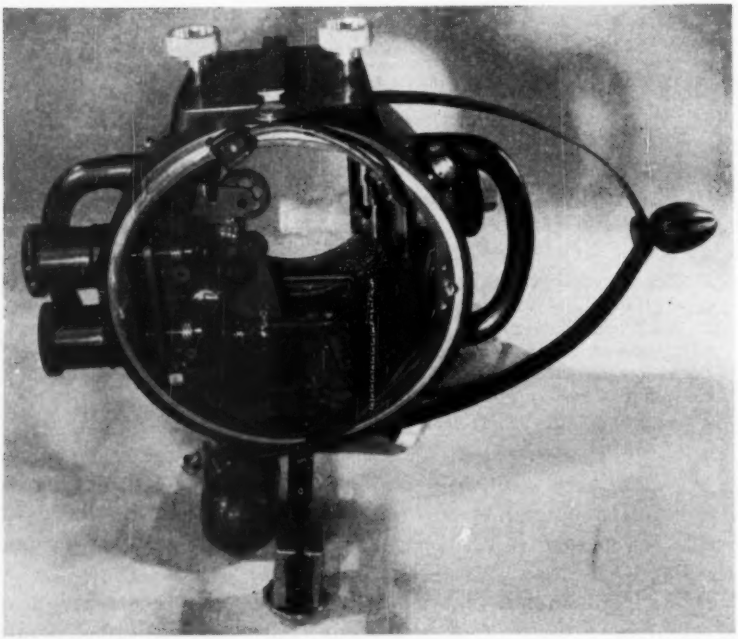
A standard 35-mm motion picture camera was contained in a hastily constructed watertight housing; but because external operating controls were completely lacking, it could be used successfully only with difficulty.

Due to its bulk, the Kluge (so named for the sound it made when dropped into the water) had little or no maneuverability, and the problems encountered with this early type of crude equipment are too numerous for discussion here.

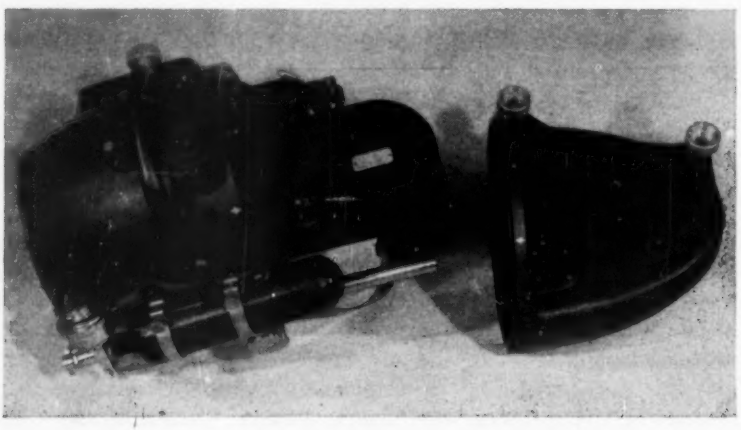
On these earlier trials, photographers were merely "checked out" on the diving equipment and a regular Naval diving crew was on location to assist and guide them.

Using the Kluge underwater blimp, the camera crews were sent to Ocala, Fla., and tried to operate under water as a camera crew would on a sound stage. Much of the film footage, time and crewmen's energies were expended shooting "slates" for each take, etc. Underwater exposure was determined haphazardly by such methods as placing an exposure meter in a glass jar, or reading the surface reflections from the water and dividing by a predetermined factor, and by on-the-spot test development. Using such cumbersome equipment and methods, the Motion Picture Section of the U.S. Naval Photographic Center completed four very fine training films

Presented: October 19, 1950, at the SMPTE Convention in Lake Placid, N.Y.



A side view of the front section of the Aquaflex 35-mm underwater motion picture camera housing reveals the geared receptacle for the Camerette and the exterior control knobs (*Photo by* Victor Kayfetz).



Front section of the Eclair Aquaflex with camera magazine battery tray and compressed air bottle in place ready to receive the rear closing section (*Official Photograph*, U. S. Navy).

for the Deep Sea Diver Series, one in 35-mm Monopac Color and three in 35-mm black-and-white.

Two later and more expensive underwater housings were built for the Berndt-Maurer 16-mm motion picture cameras. Although they included some improvements, these blimps also lacked all essential safety features and were less successful than their predecessors.

Other than a limited amount of undersea cinematography done by LCDR E. R. F. Johnson, USNR, (whose paper "Undersea cinematography" was published in the JOURNAL, vol. 32, pp. 3–17, Jan. 1939) who was recalled to active duty and utilized his own special equipment, underwater cinephotography in the U.S. Navy has been virtually at a standstill since World War II.

The "Aquaflex" 35-mm underwater motion picture camera, of French design and manufacture, was procured by the Bureau of Aeronautics for the purpose of determining its adaptability to Naval photography. The evaluation tests were conducted by the U.S. Naval Photographic Center in the clear waters off St. Thomas, V.I., utilizing Naval production motion picture cameramen who had been properly schooled to attain the rating of a U.S. Naval Deep Sea Diver.

The Eclair Aquaflex is the only camera manufactured specifically as a self-contained, motor-driven, underwater motion picture camera with external lens controls and automatic interior pressurization. This professional submarine motion picture camera of revolutionary concept is entirely independent of air supply and electric cables leading to the surface.

The Aquaflex is primarily an Eclair Camerette (Cameflex) (described in the JOURNAL, vol. 55, pp. 173–179, Aug. 1950, by Benjamin Berg, the North American Representative for the Eclair Motion Picture Camera Co., Paris, France) which is contained in an underwater housing with external controls to operate the lens diaphragm, focus, and starting switch. The Camerette is driven by a 6–8-v, 7-amp motor which is powered by four 2.6 nonspillable, lead, wet-cell batteries. It is supplied with 28-, 40-, and 75-mm coated *f*/2 Kinoptic lenses. However, these are not interchangeable under water. Small lights are located in the Aquaflex blimp to illuminate the interior exposure meter, film speed tachometer, internal-external pressure differential gage, and the film footage counter located on the 400-ft film magazine. These lights go off when the starter switch is turned down to give the motor maximum voltage. The Camerette utilizes a reflex optical system so that the diver-photographer views the image through the taking lens. The shutter may be set at any

desired opening from 200° to 35°, thus presenting an exposure choice from 1/14 at 8 frames/sec to 1/415 at 40 frames/sec.

The front section of the Aquaflex contains the plastic photographing port, the control gears and camera mount, the batteries and wiring, the pressure gages and exposure meter, plus all the necessary mechanisms for controlling the Camerette under water. The rear section covers the 400-ft film magazine, contains the three smaller viewing

Underwater Cameraman R. R. Conger, AFC, USN, in a relaxed shooting position, setting the diaphragm stop on the exterior knob (*Official Photograph*, U. S. Navy).

ports and seals the camera. The Aquaflex is delivered with two 400-ft film magazines, three 1-liter compressed air bottles, and other accessories, plus the necessary filling adaptors and camera case. The detachable wings and vertical rudder aid greatly in transporting and stabilizing the camera under water. With them it is possible to guide the camera with one hand, using the other to aid in swimming. The camera wings actually act as a planing surface, so that the

photo-diver can sight on his target through the view-finder, kick his flippered feet and guide himself by tilting and banking the camera in a manner similar to a plane flying through the air. The Aquaflex, complete, weighs about 107 lb in air, but can be adjusted to have either positive, negative or neutral bouyancy, under water.

The encased Camerette has the appearance of being rather delicate in design, but its ruggedness was proven by two accidental floodings in salt water. The equipment was rinsed in fresh water several times and blown dry with high-pressure air before cleaning each integral part with 180-proof alcohol and reoiling. On the first flooding the camera motor was metered to have almost "O" ground, but was still capable of turning the camera over at 24 frames/sec. After both floodings the Camerette and Aquaflex blimp were completely disassembled, cleaned, reoiled, and were back in operation the next morning.

During the repair operations it was found that the surface mirror on the shutter which provides the reflex vision was alcohol soluble, and so could not be cleaned with ordinary lens cleaner. This was one of the many facts omitted in the letter of instructions received with the underwater camera. Being on location, the mirror could not be recoated, but the mirror's subsurface polished plastic base provided enough reflection to continue operations. This fault was later rectified by a recoating with aluminum and an over-coating of quartz.

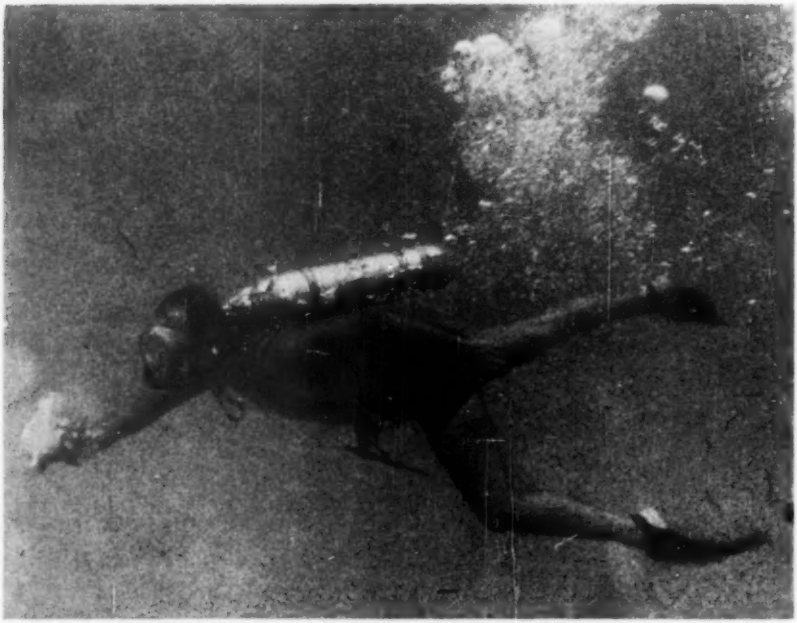
The Aquaflex is by no means leakproof, but the supply-demand type compressed air valve is so regulated that the housing contains about 3 psi over the sea pressure at any depth the camera may be taken. The camera air supply is carried in a charged cylinder, compactly arranged on the under side of the Aquaflex blimp. As the Aquaflex is descending, the demand valve increases the interior pressure to equal the depth pressure, plus 3 psi. On the ascent the demand valve closes and excess air pressure escapes through a relief valve. The 3-psi interior-exterior pressure difference should always remain the same and is visible on a gage located in the Aquaflex blimp.

Due to its design and form-fitting construction, the Aquaflex necessitates modifying the former methods of underwater motion picture camera operation as well as locomotion.

During the evaluation tests, all of the standard deep-sea and shallow-water diving helmets, as well as the standard and modified versions of the shallow-water diving face plates, used by the U.S. Navy, were tested and none was found adequate for use with the Aquaflex because of the placement of the reflex view-finder port

Of the seven American and foreign swim-type face masks tested, only one, the French "Squale" face mask, was found satisfactory. It was later found that this rubber face mask is the type used by the French underwater cinematographers.

Because the Aquaflex is a completely free and mobile underwater unit, the photo-diver must be equipped with self-contained or free diving equipment. Of all the American self-contained diving units tested, only one was found usable and it has an undesirable face



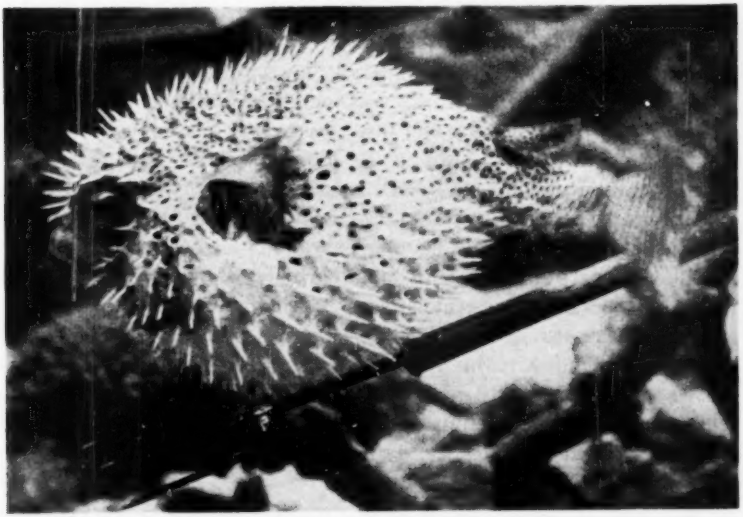
Diver wearing Cousteau Aqualung and swim fins, photographed at a depth of 85 ft, with an exposure of $\frac{1}{40}$ sec, $f/2$, using Eastman Plus X film (*Official Photograph*, U. S. Navy).

mask. This unit is an oxygen rebreathing system and is limited to a depth of 60 ft.

In the ordinary supplied-air or self-contained diving units, much of the diver's time, movement and thought are consumed in the manual regulation of his breathing system control valves. This is undesirable for photography as the diver may have to stop in the middle of a "take" for this operation. The French "Aqualung" was tested and found to be a completely automatic compressed-air self-contained diving unit. It has a separate mouthpiece breathing

hose with which the "Squale" face mask may be used. This is the ideal situation as it leaves the photo-diver's hands free to operate the camera, and his mind is free to concentrate on his photographic work and the sequences needed.

Both the Aquaflex and the Aqualung operate on the same automatic supply-demand principle. The greater the water pressure, the greater the pressure of the air supplied to both the diver and the Aquaflex. Both the camera and photographer are of neutral bouyancy so that the photographer, with the aid of swim fins on his feet, is able to



Puffer, or blowfish, photographed at a depth of 40 ft
(*Official Photograph*, U. S. Navy).

swim with the camera in any direction or to any depth down to approximately 200 ft.

During the tests the photographer descended with the Aqualung to a depth of 120 ft. With the Aquaflex he descended to a depth of 95 ft and obtained usable film footage without the use of supplementary lighting equipment.

However, it cannot be too highly stressed that all the compressed-air diseases, intoxicating effects, and decompression problems which plague the diver using other deep sea rigs are also present when using the Aqualung, and the photo-diver must be in excellent physical and mental health and thoroughly trained as a diver.

Once the photo-diver is completely familiar with his equipment, he will find it an easy matter to swim after and photograph large fish and other moving objects, obtaining angle, follow and moving shots, hitherto undreamed of. He will find that the camera maneuvers easily under water even in currents and tides. When using the Aquaflex and the Aqualung, he may hover over his subject—rising and falling only an inch or so with his own respiration—to make steady shots comparable to tripod shots.

The clear waters most favorable for undersea photography are found in tropical bays, lagoons and other sheltered areas were the horizontal visibility is greatest. These warm, still waters are also attractive to large and oftentimes potentially dangerous fish.

The photo-diver's working location is usually on or near the sea bottom where there are moray eels, octopuses and other fearsome-looking creatures. During the tests, these fish did more to enhance the picture value than to hinder the photographer. The underwater crew encountered quite a few manta or sting rays, several large sharks, many barracuda (one of which measured $5^1/_2$ ft in length), and three moray eels, one having a head at least 5 in. wide. The bat-like appearance and thrashing barbed tail of the fast-moving manta rays made the crew uneasy, although none attempted to attack. With explosives, the crew killed a shark which measured over 14 ft in length. Many large barracuda approached the crew as close as 7 ft and actually swam with them, but seemed merely curious. The moray eels live in and around small caves in the coral and are definitely dangerous.

Oddly enough, the photo-diver's most troublesome enemy is the coral. After prolonged exposure to water the diver's skin is soft and is easily cut on the jagged coral. These wounds take six weeks or longer to heal and leave pronounced scars. However no fish were attracted by bleeding from cuts of this type.

The underwater use of the Aquaflex by the motion picture and television industry is limited only by the imagination. The undersea life is intensely interesting. It is a beautiful new world to be brought to the screen.

For the teacher, underwater films can bring to the classroom an accurate living and biology text in color.

For the scientist engaged in various phases of underwater research, pictures can be obtained which would permanently record the performance of ship hulls, the geological features of sea bottoms, and the characteristics and habits of plant and marine life.

35-Mm Ansco Color Theater Prints From 16-Mm Kodachrome

By ADRIAN MOSSER

Filmeffects of Hollywood, Calif.

and LINWOOD DUNN

RKO-Radio Pictures, Inc., Hollywood, Calif.

SUMMARY: This paper describes one of the successful methods of bringing the 16-mm motion picture to the 35-mm screen in color. The information presented is the result of more than two years research and work in this field by Filmeffects of Hollywood.

The present Ansco 35-mm color method for motion pictures has been in successful use since 1945. It consists principally of Ansco 735 as the camera film, which is a 35-mm three-color stock of the reversal type, printed on a higher contrast reversal stock, Ansco 732, which is color-balanced with the 735.

The Ansco Color 732 has also been found to be ideally suited to the making of 35-mm three-color theater prints directly from 16-mm reversal color originals. The 732 stock is exposed on an optical printer, enlarging from the 16-mm color original. The sound is printed from a 35-mm direct-positive sound track and the film is processed, waxed, and is then ready for theater projection. In this simple manner, a three-color image can be transferred from a 16-mm original directly to a 35-mm theater print, in one step. There are no intermediate films involved, and there are no registration problems. Prints can be made at the rate of thirty to sixty feet per minute.

The simplicity of this direct blowup color print procedure, combined with the economy of shooting three-color productions on a low cost 16-mm original, makes this method highly attractive to producers who require only a limited number of release prints for their particular market, and to whom costs are of paramount importance.

In the last two years, some theatrical producers, principally foreign, have produced feature length films on Eastman Kodak's excellent 16-mm Commercial Kodachrome, for release in 35-mm Ansco Color, through this direct blowup method. The over-all savings are appreciable, where the quantity of release prints required is small, as compared to the cost of working in any other 35-mm three-color method.

Presented: October 11, 1949 at the SMPE Convention in Hollywood.

The old major studio maxim, "film is the cheapest thing on the lot," does not apply to this class of production, as the budgets are closely calculated for a limited market. Additional costs incidental to photographing in 35-mm three-color, such as raw stock, laboratory processing, shipping and equipment costs, might well determine the difference between profit and loss on some productions.

Another use for direct blowup theater prints is for the industrial and documentary film market. As a rule producers in this field work exclusively in 16-mm color, and their films are exhibited to 16-mm nontheatrical audiences. Occasionally, however, there will be a need for a few 35-mm color prints for special showcase showings in theaters and large auditoriums. Inasmuch as intermediate film steps are not necessary before the first print can be made, even a single print may be ordered without incurring the usual costly preparation work.

For many of the producers using the direct blowup release print process, it is their first attempt at making a film in color. Shooting in 16-mm sometimes misleads to further economy, particularly in the selection of equipment and technical personnel. Such economy is false, and can be quite disastrous when the film must compete in the theaters with original 35-mm pictures. The smaller size and comparatively low cost of 16-mm should not lead the producer to believe that other requirements have been reduced proportionately. As in all color processes, the quality of the release print depends a great deal upon the perfection of the original photography. A poorly photographed scene in black-and-white can often get by because its deficiencies are recorded only in tones of gray. The same scene photographed poorly in color will usually show up badly and as a glaring misrepresentation of reality.

The cameraman must pay particular attention to lighting contrasts, color values, and exposures. Also, filming in color causes the problems of make-up, costuming and set decoration to grow in importance. All of these arts become increasingly vital factors to be considered in striving for photographically smooth 35-mm color theater prints.

Cameras and accessories must be selected with great care. Excellent professional 16-mm equipment, with critically sharp lenses, is now available. This equipment is of standard design, and can be used in conjunction with most other existing studio equipment, with little change in operative technique required. Most of the difficulties incurred by cameramen shooting color for the first time, arise from insufficient knowledge of the limitations of the particular material they are using. For this reason, it is just as important in 16-mm to

use seasoned technicians, as it is in any other color photography, regardless of the type or size film used.

Editorial work can be carried out in several ways. If desired, a 16-mm color work print or black-and-white reversal work print can be made. For 35-mm producers, perhaps the handiest method would be to use a 35-mm black-and-white work print, which allows for editorial and dubbing operations to proceed in conventional fashion, utilizing standard equipment. Filmeffects has developed a method of making blowup black-and-white work prints economically, and with maximum safety to the original. This method consists of printing a 16-mm black-and-white dupe negative from the original, on positive stock using a continuous printer. This "temporary" dupe negative is then put in a special high-speed blowup printer, which enlarges to 35-mm black-and-white safety positive stock. Edge numbers from the 16-mm color original are transferred to the sound track area of the 35-mm work print during the procedure, making the matching of the original color a comparatively simple job. Great care should be taken in the handling of the original film, as the slightest abrasions or scratches are obviously magnified in the 35-mm blowup. The best of major studio negative cutting procedures should be practiced to the letter in order to insure the cleanest and most nearly scratch-free original possible. Plans are now being made to offer to producers in this area, a new film lacquering service which should insure a much wider margin of safety in the handling of originals.

When a great number of lap dissolves are desired in a release print, the original is generally assembled in A and B rolls. This arrangement permits the dissolves to be made each time while printing directly from the camera original. If the optical effects are few or involved, dupe sections incorporating the effect can be cut in with the original. Corrections are made semiautomatically, where necessary.

Although routine color release printing is generally done from the 16-mm original to obtain the highest quality prints, producers occasionally require 35-mm black-and-white negatives for certain export use, where the market may be more limited. This type of work has proven to be quite satisfactory, and very acceptable commercially. 35-Mm color printing masters can also be made from the 16-mm original, for the making of theater prints by contact.

The Acme-Dunn Optical Printer used in making the Ansco Color blowup release prints, features a 16-mm projector head equipped with a Bell & Howell type shuttle movement. This movement is fitted with two register pins placed side by side to accommodate double

perforated originals, or they can be reset one above the other for the single perforated. The 35-mm camera head is also of the Bell & Howell type, with a positive-matted aperture, and a variable opening shutter for the making of fades and dissolves. The light source is a 750-w projection lamp, fitted with a highly efficient condensing system. Provision is made between the lamphouse and film for diffusion screens and color-correction filters. Lenses used are the 4-in. *f*/4.5 Cooke Copying, and the 4-in. *f*/2.8 Eastman Printing Ektar.

In most cases, a single print is made in one passage of the original through the printer. Sound synchronization is indicated at the tail end of the newly exposed reel of raw stock, which is then run tail end first through a 35-mm sound printer to make the sound track exposure. The track required for this process must be a 35-mm positive image in negative position, generally obtained by re-recording to a direct positive. The exposed print is then processed by the Houston Color Laboratory, the average time being about 9 min in the first developer and 7½ min in the color developer, using the Ansco Color 732 release positive stock. A temperature of 68 F is maintained in both the first and second developers. During processing, the sound track area is sulfide-coated to render the unexposed areas of the dye track opaque. Twenty-five to fifty prints are usually sufficient to meet the requirements of the market for this type of production.

We are grateful for all of the help we have received in this work, from the expert technicians connected with the companies mentioned. With their continued cooperation, we hope to advance further, making use of the promising new commercial color films which we know the next year will bring forth. The future looks bright for the 16-mm color theatrical producer, as quality will improve and the costs should be reduced.

New Laboratory for Processing Monopack Color Film

By KRISHNA GOPAL

Film Division, Government of India, Bombay, India

SUMMARY: A new laboratory has been designed to utilize for the first time the system of pump and spray processing for all its different operations, except for the developer.

With the increasing demand for color in this country it was thought that the introduction of a system which called for little change in equipment as far as cameras and other studio equipment was concerned, would be ideal for the purpose. Studios in India are fairly well equipped with cameras, possessing as they do the latest, and in many cases even the BNC Mitchells, and the equally good Continental Super-Parvos, but the use of arcs is still a luxury which few can afford. Under the circumstances a color film of the monopack variety adapted for a color temperature of the Tungsten light was considered the most suitable as a solution of India's immediate needs for color.

The Gevaert organization of Belgium had recently put their "Gevacolor" on the market and their local agents offered to import this material in limited quantities. Samples were offered to different producers, tests were carried out, and the exposed negatives flown back to either Antwerp or Brussels for processing. The results were satisfying, but little more could be done because local producers insisted on seeing their rushes within two or three days if not on the next day, while the time it took to fly the film to the continent and back was sometimes as long as one month or more, if no import difficulties were encountered. There seemed no other alternative but to build a laboratory in India itself.

The writer has been interested in color for some considerable time, and it fell to him to design this particular laboratory. The demands of Gevacolor film, which in principle are perhaps the same for all such color material, were carefully studied in personal discussions with Gevaert technicians. Independent laboratories, such as those of Eclair in Paris and Denham in England, were also consulted because of their experience in processing this type of film. As a result of these studies the present laboratory was designed. The construction itself

A Contribution: Submitted July 11, 1950.

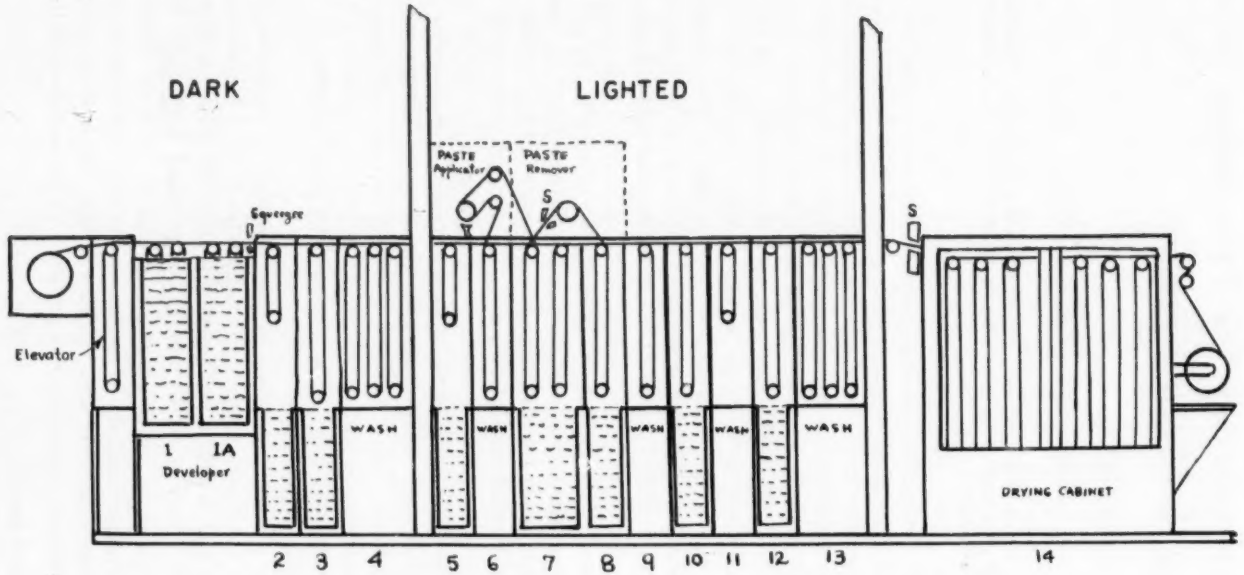


Fig. 1. Diagram of pump and spray processing machine for Gevacolor film.

1–1A, Developer; 2, Stop; 3, Hardener; 4, Wash; 5, Dilute bleach; 6, Wash; 7, Bleach; 8, Stop; 9, Wash; 10, Fixing; 11, Wash; 12, Hardener; 13, Wash; and 14, Drying.

was entrusted to a local firm specializing in this class of work, and was taken in hand early this year. Five months later the machine was ready for operation. Utilizing as it does the pump and spray instead of deep tank processing for twelve out of its thirteen operations, this machine is believed to be the first of its kind.

Gevacolor film, like Ansco film, has its color formers incorporated within each of its three layer emulsions, but unlike Ansco it is not of the reversible type. Instead it develops into a negative having colors complementary to the original subject, and has to be printed on a similar though slower material to produce a color positive. A first development in a normal developing bath is therefore unnecessary, and the film is led directly into the color developer.

Briefly the layout of the machine (Fig. 1) is as follows:

Exposed film, after passing through a normal feed elevator assembly, passes straight into the developer tank (Fig. 2). This is provided with eight powerful underwater jets directed against each of the moving strands of film and fed by a high-capacity, stainless-steel pump. Solution for the pump is drawn from the bottom of the tank. A subsidiary inlet at the intake of the pump provides a means for continuous replenishment. At this stage any developer carried over by the film as it emerges from the tank is drawn off by means of a suction squeegee. After this first development the film does not enter any deep tanks for further treatment, but is led instead into a series of stainless-steel cabinets mounted over tanks of similar material. Solutions from these tanks are pumped through strong jets on the emulsion side of the film from the top, whence it flows down the moving film and returns to the tank below (Figs. 3 and 4). For continuous replenishment, the same method is employed as that for the initial developer. It will be noticed from the accompanying diagram (Fig. 1) and photographs that in no cabinet does the loop of film descend low enough for any direct contact with the solutions. The different steps for negative development are:

1. Developer	5. —*	9. Wash	12. Hardener
2. Stop Bath	6. —*	10. Fixing	13. Wash
3. Hardener	7. Bleach	11. Wash	14. Drying
4. Wash	8. —*		

* Used only for positive prints (see text below).

The treatment for positive development is slightly different. The first development takes place in a second tank, the contents of which are slightly different, mainly in its bromide content, from those of the negative developer bath. Thence, the procedure up to wash No. 4

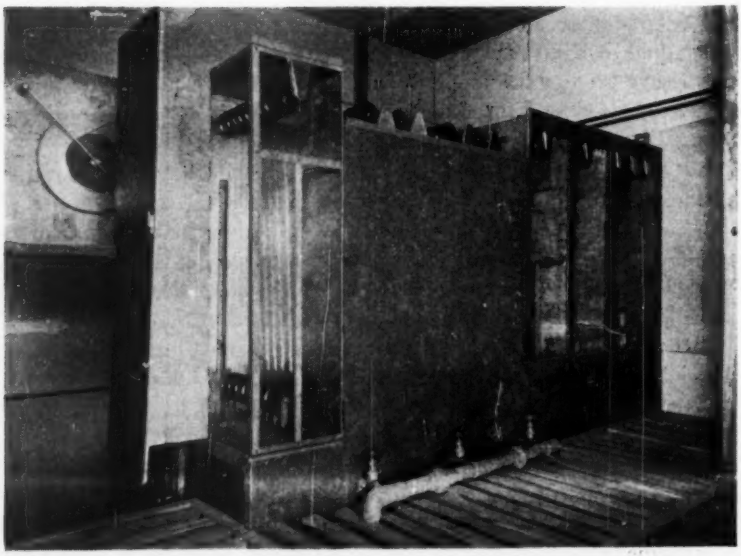


Fig. 2. View of the dark section of the developer tank with elevator cabinet open.

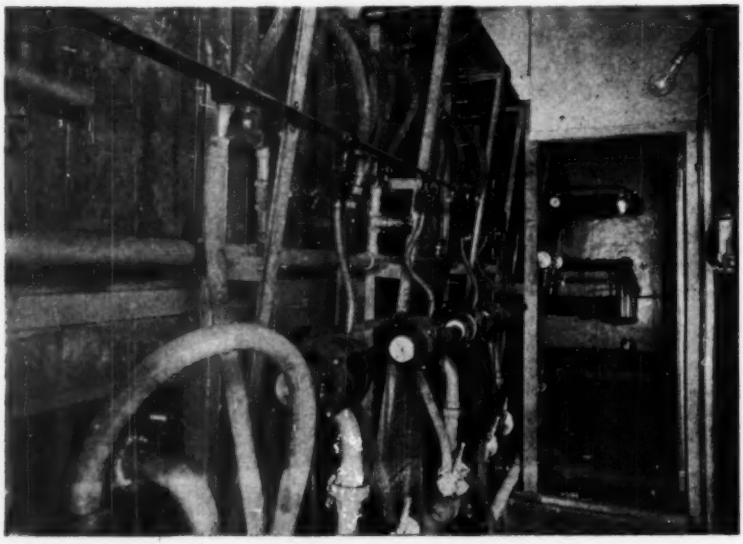


Fig. 3. Rear, close-up view of the machine from the drying end, showing pumps, motors, piping, etc.

is identical. Then a dilute bleach and wash are given in cabinets 5 and 6, after which the film is brought out on top of the cabinet where a special applicator applies a paste containing the main bleaching solution on the picture side only, leaving the sound side untreated. The film then enters cabinet 7 and is allowed to run on the first bank without the pump being switched on. Once more it is brought out on top, the paste removed by means of a suction squeegee, and thence

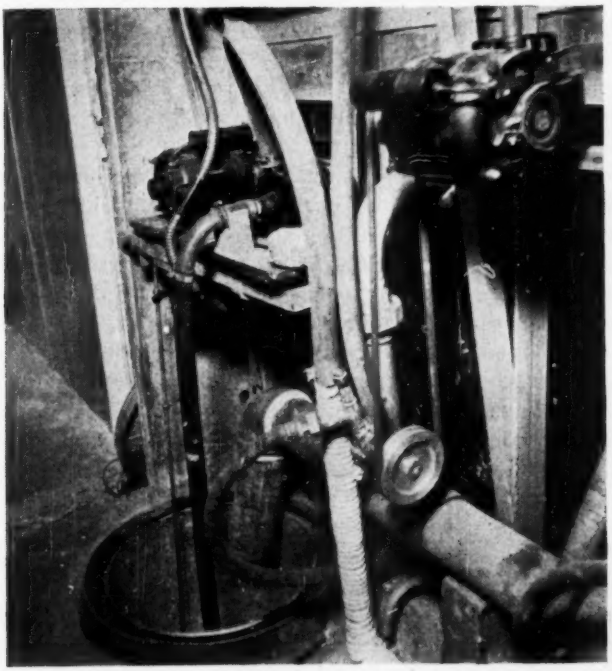


Fig. 4. Rear, close-up view of the machine, showing one circulation pump and chilled water pump.

taken to cabinet 8 for a further stop bath, and thereafter through the wash-fix-wash-hardener and wash stages exactly as for the negative. This treatment leaves the film with an unbleached, black-and-white sound track.

To facilitate these change-overs, all top shafts are provided with independent clutches. The drive itself is by means of one drive sprocket per shaft screwed tightly to it and after the first free roller.

There are in all six free rollers besides the sprocket, providing for six loops per bank.

The lower assembly has all independent and freely moving rollers and is itself capable of free movement in a vertical direction alongside two stainless-steel guide rails. It is sufficiently weighted to give the requisite amount of tension to the film.

A partial view of the lighted section of the machine is shown in Fig. 5.

The over-all speed of the machine is 500 ft per hr, and the size of the film loops is approximately 4 ft each, giving an approximate time of 5 min for each bank.

As the time required for certain operations is less than 5 min, the guide rails have been extended allowing the lower assemblies to be suitably raised to give the correct time.

Friction drive has not been very popular in this country, and while it would probably have given much smoother results in the long run, it was felt advisable to retain standard Indian practice in at least this respect, everything else being so revolutionary and more likely to keep the operators' attention engaged elsewhere.

The construction is of stainless steel throughout, except for such parts as do not come in direct contact with the solutions. The pumps are of American manufacture. The drive sprockets, as well as all the free rollers, have been so designed that they can accommodate both 35- and 16-mm film. The machine can thus be used for both sizes of film, although it has not yet been tried out with 16-mm film.

Temperature is regulated by providing thoroughly insulated jacket tanks for all solution tanks, round which precooled water is circulated. Two independent systems have been provided, one exclusively for the developer with a thermostatic control differential up to 0.5F, and the other for the rest of the solutions and with a much broader thermostatic differential control. As an additional precaution against undue rise of temperature, both the dark and the lighted ends of the machine have been air conditioned to a temperature of about 72F.

The drying cabinet has been placed in the general drying room of the main laboratory building along with three other drying cabinets for standard black-and-white Fonda machines (Fig. 6). At present the film is dried by heating refiltered room air to a temperature of about 90F, thus getting whatever reduction in humidity is possible, and driving this air through the cabinet by means of a blower of the fan type. This air is finally allowed to escape into the outside atmosphere. As proper control of humidity is not possible by this method, plans for a complete dehumidifying and air-conditioning unit are

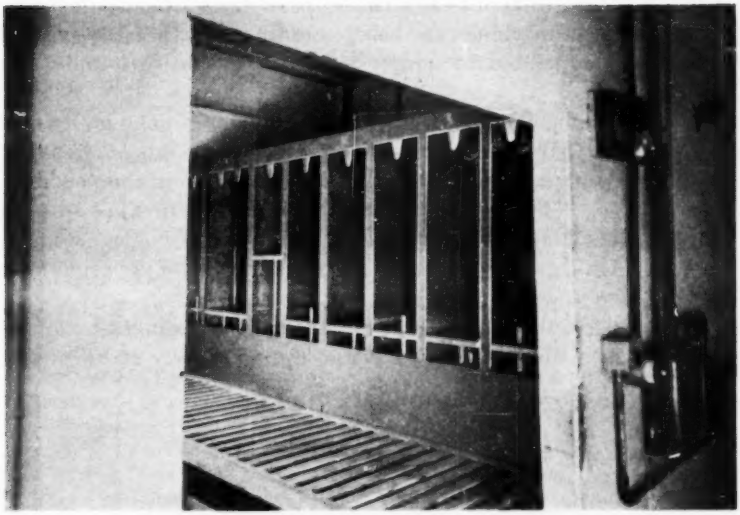


Fig. 5. Partial view of the lighted section of the main machine.

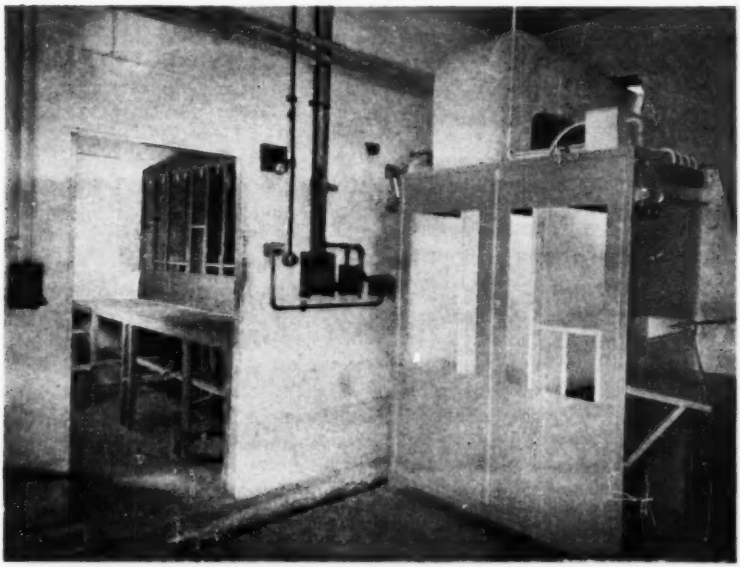


Fig. 6. Front view of machine, showing drying cabinet and portion of lighted section. Air filter has been removed.

under way, but in the meanwhile by-pass ducts from the existing black-and-white machines are being connected, so that the existing units could be utilized by simply shutting off the black-and-white machines.

The main difficulty however, was to obtain 400 to 500 gal of cold water at about 65F per hr for wash purposes. When it is realized that the average temperature of water in this country is in the neighborhood of 85 or 90F, the difficulty will be appreciated. The existing plants in the laboratory were found to be hopelessly inadequate, and a special high-capacity cooler of the instantaneous type had to be installed.

The total electrical load for the machine, including all motors, pumps, coolers, air conditioners, etc., is approximately 25 kw.

Errata

M. Rettinger, "A magnetic record-reproduce head," *Jour. SMPTE*, vol. 55, p. 390, Oct. 1950.

Page 390, line 3: *For* .016 *read* 16

Ibid., lines 20 and 21: *For* 3 cu/cm or .183 cu in./cm). *read* 3 cu cm or .183 cu in.).

68th Semiannual Convention

The 1950 fall convention of the Society was the first in many years to be held away from a large city. Society Officers, whose duty it was to select the place of meeting, felt that easy exchange of ideas and renewal of old friendships during recent big city meetings had been reduced to nearly zero by attractive opportunities to "do a little business" between sessions. As a consequence, the comradeship that characterized earlier Society conventions had all but disappeared. Feeling that business and current increase in membership, together with the addition of a comparatively heavy interest in television matters should not be permitted to depersonalize these functions, they agreed to try holding another resort convention. The unanimous choice was the Lake Placid Club in the Adirondack Mountains of upper New York State. Enthusiastic attendance of members from all parts of the United States and Canada proved the appropriateness of this location as a site for the Society's 68th convention in thirty-four years.

Sufficient free time between sessions or committee meetings was provided for old-timers to talk with their friends, and for members newly active to meet others with common interests. Ample discussion time during technical sessions was allowed also, by limiting in advance both the number and length of papers scheduled. Members were generally enthusiastic about the way this convention was handled, favoring particularly the unhurried atmosphere.

Several equipment displays in the lobby of the Club attracted members during off hours. General Precision Laboratories demonstrated a 16-mm professional projector which was recently developed. Mr. Frank H. McIntosh had his unique amplifiers on exhibit, with several new magnetic recording and reproducing equipments made by Westrex. RCA showed microphones, recording equipment and a 16-mm sound projector, equipped to reproduce release prints having magnetic sound track in the conventional photographic track position. Reeves Soundcraft provided the release prints. Members who were not familiar with equipment used in high-speed photography, examined thoroughly the Fastax Camera, displayed by Wollensak.

Coffee, light refreshments and a comfortable place for off-hours conversation were provided to all comers by the Club Coffee Shop, which remained open throughout the convention under the generous auspices of the Radio Corporation of America.

Board of Governors Meeting

Preceding the convention opening by one day, the Board of Governors met Sunday, October 15, to hear reports of Society activities for the third quarter of the year. Recommendations to individual officers, as well as to the Society headquarters staff were made, covering current policy questions and certain specific aspects of the Society's work for the concluding quarter. Among items on the Board's agenda were: individual and sustaining membership programs; the consideration of possible scholarships that might be awarded sometime in the future; a plan to revise the Society's Administrative Practices (those general rules which apply to operation of committees and the Headquarters office), and the current work on the design of a new Society emblem to symbolize in simple style the scope of the Society's work more adequately than does the present combination of film reel and television picture tube.

At the close of the meeting, a panel of tellers was appointed to count ballots for the annual election of members to the Board. Successful candidates were:

Peter Mole, President; Herbert Barnett, Executive Vice-President; John G. Frayne, Editorial Vice-President, William C. Kunzmann, Convention Vice-President; Robert M. Corbin, Secretary; and Governors—William B. Lodge, Oscar F. Neu, Frank E. Carlson, Malcolm G. Townsley, Thomas T. Moulton, Norwood L. Simmons and Lloyd Thompson.

These new officers and Board members assume their official duties January 1, 1951, but many will have been busy during the intervening months with appointment of committees, potential project assignments or plans for some portion of the 1951 budget.

Lake Placid

Transportation to the convention threatened to be a problem, since all available space on Colonial Airlines and on New York Central trains to Lake Placid had been reserved from Saturday through Monday, October 16, by Society members. Supplemental transportation, however, was furnished by a large number of East Coast members who drove their own cars so that no one was left out. There were several who drove long distances: Mr. and Mrs. Emery Huse from Hollywood; Mr. and Mrs. George Colburn from Chicago; and Mr. and Mrs. R. T. Van Niman from Indianapolis.

Many arrived early or stayed after the proceedings had officially terminated on the afternoon of Friday, October 20, to enjoy the scenery or play a little golf. Total registration was 218, not including Army, Navy and Air Force representatives. Bill Kunzmann's most optimistic estimate of attendance was exceeded by at least nineteen registrants.

In accord with Earl Sponable's plan to have informality prevail, there was no formal luncheon on Monday and no awards were presented during the banquet and dance Wednesday evening. The threat of "no speeches" which had become a familiar and traditional figure of speech was at last a well-kept promise, with the result that not a single formal word was uttered during the mid-week festivities. To the contrary, some of the members provided a handsome share to their own entertainment. George Colburn made more than tolerable music come out of a "musical broom." John Frayne distinguished himself by "calling" several square dances in his best stentorian tones.

Not all was fun and frolic, however, for the convention did have its serious side. Ed Seeley, Program Chairman, with the generous aid of Walter Simons and the entire Papers Committee, had prepared a well-organized program of technical papers. Related items appeared on the same session so that members who were interested in only one group of papers were not required to sit through the entire convention to hear them. All papers on the program are listed at the back of this issue. One paper from this convention appeared in the November JOURNAL and six others are published in this issue.

The Annual Business Meeting of the Society was called to order at 2:00 P.M., Monday afternoon, by Mr. Sponable. Members were asked to vote on formal approval of the proposed award of Honorary Membership to Dr. Zworykin for his early work in the development of television. Approval was unanimous.

Magnetic tape recordings were made of all the questions and answers that made up the discussions following many of the 51 papers or reports presented during the 9 technical sessions. Throughout the convention, Harry Braun and Bob Sherwood operated both the Altec public address equipment and RCA tape recorder. The Columbia Broadcasting System furnished four microphones, used to pick up discussion questions from the meeting floor. Immediately following the convention, Clyde Keith had the recordings transcribed and has since provided the

Editor with 50 pp. of manuscript that should add materially to the value of the papers when they appear later in the pages of the JOURNAL.

Publicity was very nicely handled by Harold Desfor and by Miss Melican of the Society Headquarters staff, who wrote and released two publicity stories each day, one mailed from Lake Placid and the other delivered at the same time by messenger in New York to the wire services, motion picture and television trade papers, and the New York daily newspapers. As a result of careful attention to publicity, this convention received better press coverage than any previous one.

The reaction of nearly all who attended was enthusiastic and, without being trite, it is safe to say that from nearly all viewpoints the 68th Convention was a success. There was one unfavorable aspect, however, that deserves mention. The remote location made it impractical for many members, who usually attend for one or two days, or who wished to hear specific papers, to be on hand. Under more customary circumstances, when a convention is held in New York City or in Hollywood, nearly one-half of the 400 to 800 members who attend do so on a daily basis. These members are persons whose interest is specialized or whose work prevents them from attending all sessions. They are the ones who stand to benefit most from papers and subsequent discussions. Being largely Associate and Student members, they will ultimately be the Active members of the Society and, consequently will be accepting positions of future responsibility in the industry.

ANNUAL AWARDS

Growth of both motion pictures and television from a comparatively few basic ideas to the proportions of a major industry has been marked by occasional technical milestones, each primarily contributed by one individual. The Society attempts to recognize these important contributions by conferring several annual awards to persons adjudged most worthy of receiving such honors. This year, one entire session, Monday evening, was set aside for recognition of the work of twenty-one individuals.

New Fellows of the Society

President Sponable formally inducted the following as new Fellows of the Society:

Gerald J. Badgley, U.S. Naval Photographic Center
George L. Beers, Radio Corporation of America, RCA Victor Div.
Herbert E. Bragg, Twentieth Century-Fox Film Corp.
Fred W. Gage, Warner Brothers Pictures, Inc.
Raymond L. Garman, General Precision Laboratory, Inc.
Watson Jones, Radio Corporation of America, RCA Victor Div.
Frederick J. Kolb, Jr., Eastman Kodak Co.
John P. Livadary, Columbia Pictures Corp.
William B. Lodge, Columbia Broadcasting System
Boyce Nemec, Society of Motion Picture and Television Engineers
Charles Rosher, Metro-Goldwyn-Mayer
John H. Waddell, Wollensak Optical Co.
Emerson Yorke, Emerson Yorke Studio

Dr. Frederick J. Kolb, Jr., (center) of the Eastman Kodak Co., receives the 1950 Journal Award from Earl I. Sponable, President of the Society. At left is Charles R. Fordyce, also of Eastman Kodak Co., who received the Samuel L. Warner Memorial Award Medal.

Journal Awards

Frederick J. Kolb, Jr., of the Eastman Kodak Co., was presented the Journal Award for "Air Cooling of Motion Picture Film for Higher Screen Illumination," published in the December 1949 JOURNAL.

C. R. Keith, Western Electric Co., and *Vincent Pagliarulo*, then of the Western Electric Co. and now with Technicolor Motion Picture Corp., received honorable mention for "Direct-Positive Variable-Density Recording With the Light Valve," published in the June 1949 JOURNAL.

Robert Herr, *B. F. Murphey* and *W. W. Wetzel*, of the Minnesota Mining and Manufacturing Co., received honorable mention for "Some Distinctive Properties of Magnetic-Recording Media," published in the January 1949 JOURNAL.

New Honorary Members

Dr. Edward W. Kellogg, long and well known to Society members as Director of Advance Development for RCA Victor Div., now retired, was formally made an Honorary Member of the Society.

Dr. V. K. Zworykin, Vice-President and Technical Consultant for RCA Laboratories, Princeton, N.J., was made an Honorary Member.

Samuel L. Warner Memorial Award

Charles R. Fordyce, of the Eastman Kodak Co., was presented the medal of the Samuel L. Warner Memorial Award for his efforts and the achievement of the development of triacetate safety base film.

Dr. Fordyce was born in 1902 at Springville, Iowa. After receiving his AB

Dr. V. K. Zworykin, (left), Vice-President and Technical Consultant of RCA Laboratories Div., is presented with the Society's Progress Medal by Earl I. Sponable, President of the Society.

and MA degrees from Cornell College in Iowa in 1925, he attended the graduate school of Cornell University, Ithaca, N.Y., from which he received his PhD degree in 1929.

In July, 1929, Dr. Fordyce became associated with the Eastman Kodak Company as a chemist in the Kodak Park plant. The following 15 years he devoted to research work on the manufacture of cellulose derivatives and their commercial uses for photographic film base and for plastics. In 1944 he was appointed Assistant Superintendent of Kodak Park's Department of Manufacturing Experiments and in 1947 Superintendent of that Department, which position he holds at the present time. His duties include supervision of experimental and plant development work on the manufacture and improvement in quality of photographic film. He is the author of several technical papers on the chemistry of cellulose esters and of over fifty patents, most of which concern cellulosic materials and their uses for photographic film and plastics.

Dr. Fordyce has served as Secretary of the Division of Cellulose Chemistry of the American Chemical Society from 1939 to 1944 and as Chairman in 1948.

Progress Medal Award

Dr. V. K. Zworykin, Vice-President and Technical Consultant, RCA Laboratories Div., Princeton, N.J., was presented with the Society's annual Progress Medal Award, in recognition of outstanding contributions to the development of television.

Dr. Zworykin was born in Mouron, Russia, in 1889. He was graduated from the Petrograd Institute of Technology with the degree of Electrical Engineer. At the close of World War I he came to the United States and promptly became

a citizen. He received the degree of Doctor of Philosophy from the University of Pittsburgh in 1936. Soon after coming to this country, Dr. Zworykin joined the research staff of the Westinghouse Electric and Manufacturing Co. where he worked in the fields of photoelectric emission and television. Some of this work involved photosensitive devices for sound motion pictures. Dr. Zworykin's conception at this time of the principles of the iconoscope and the kinescope laid the basic foundation for his work on the development of all-electronic television.

In 1929 Dr. Zworykin became associated with RCA as Director of the Electronic Research Laboratory, and in 1947 he was made Vice-President and Technical Consultant of the Radio Corporation of America, RCA Laboratories Division.

Although Dr. Zworykin has probably contributed more than any other man to the science of television, he has not confined his talents to this one phase of the electronics art. His broad interest in varied fields of endeavor has always been an outstanding characteristic of his scientific work. This is illustrated by the fact that the U.S. Patents which he holds range from gun-fire controls to devices for reducing star motion in astronomical instruments.

Dr. Zworykin has made important contributions to the technical literature on television and electronics through publication of technical articles and in particular through coauthorship of four books: *Photocells and Their Applications*, *Television*, *Electron Optics and the Electron Microscope*, and *Photoelectricity and Its Application*.

Guest Speaker

Terry Ramsaye, coming to the Convention as the sage of New Canaan, Conn., and Consulting Editor of the *Motion Picture Herald*, noted: "We have all come a long way to be here tonight . . . not measuring miles but rather milestones of progress of this Society. An observer seasoned with experience must realize that, when he scans the agenda of this convention and surveys the array of scientific skills and achievements represented in the registration and this audience.

". . . there is evidence of a growing consciousness in the Society of its development into an order of entity which the industry, with its arts of expression and communication, has never had before. It has had to come by evolutionary processes."

[From the speaker's inimitable and widely ranging recollections of scientific and economic developments, only the following paragraphs are recorded.]

"The currently widening horizons of this Society arrive in a most timely fashion. For far too many years the technology, the engineering, was something special. It was apart and far remote from the predominant interests of the industry. A large proportion of the early scientific magic for the movies came from Rochester in a can. And after the can arrived the rest was done largely by rule of thumb and little secret formulas in the hip-pockets of the cameramen and what we called 'laboratories.' I can well remember when about 1914–15 I had to exert extreme pressure to get cameramen of the movies to use panchromatic negative. Some of the best of them told me it was the bunk . . . .

"The basic motion picture originated in sources far external to the amusement world, including Room 5 of the Edison Laboratories. Color became a commercial fact from a technological group centered at the Massachusetts Institute of Technology, led by Dr. Kalmus. Sound was added to the implementation of the screen from the outside, too, from such sources and contributors as DeForest, Case and Sponable, the Telephone Company and General Electric. I hardly need to comment about television. . . Every big scientific and technical enhance-

ment of the art has had to fight its way into acceptance. None has been really welcomed.

"Small wonder then that the Society has been a while winning a way into the appreciation and understanding of movieland. Today that process is well under way. The time is auspicious.

"Contemplating my appearance here before you this evening I turned back to the record of an occasion eighteen years and ten days ago when I spoke before the Society. I was bold enough then to suggest that it would be wholesome if the motion picture industry could be imbued with some of the respect for discipline in their art and commerce in something of the same terms in which the engineer has to regard the laws of his science and craft.

"Also in the memory of that night those eighteen years ago are some pointedly germane utterances from Dr. Alfred N. Goldsmith, with whom I shared the platform. Let me read a paragraph or two from his remarks that night. He was most prophetically relevant.

" 'The SMPE is beginning to feel that it is coming to be regarded as the major exponent of organization and of systematic analytical endeavor in the field of motion pictures by important manufacturing and producing interests. . . . Some of these interests have, unfortunately been slow to recognize how important the Society can be to the industry. Some of them have developed their own individual organizations within their own corporations to a high degree, but they have failed to understand that this is not sufficient. It is necessary to organize the whole industry . . . so that one may not interfere with the progress and development of the other.'

"Progress has been made, but what he said then may well be said again. The inclusion of the field of television, which is in fact another device for the capture, creation and transmission of motion pictures, in the functioning of this Society is a direct step in the indicated direction. It will be well if this Society should become more audibly articulate about itself and its works. . . ."

New Society Medal

The Board of Governors of the Society has just approved, by letter-ballot, the creation of a television award medal to take a place beside the Samuel L. Warner Memorial Medal and the Progress Medal, which are presented annually to the individuals who have contributed most to the science of sound recording and to the general field of motion picture technology.

The new award, to serve as a symbol of recognized achievement in the combined fields of television and theater television, has been offered by the Radio Corporation of America, through its President, Frank M. Folsom. It will consist of a gold medal and formal certificate of achievement, made available annually for presentation to an individual selected by a Society Award Committee.

Recent technical contributions will be the major consideration in selecting the recipient, who must have personally done the work which qualifies him, or if others were importantly concerned, he must have contributed the basic idea and have been intimately associated with its subsequent development.

The award, to be first presented in 1951, will be known as the "David Sarnoff Medal," bearing the name of a distinguished industrial executive, who is recognized to have played a major role in aiding the technical development and subsequent successful commercialization of television.

Engineering Activities

New Staff Engineer

Henry Kogel is the Society's new Staff Engineer, having replaced Bill Deacy who resigned to take up the challenge of engineering opportunities with Reeves Soundcraft.

Henry Kogel has come to the Society from Sperry Gyroscope Co. where he was a Project Engineer, specializing in developmental work on demodulators, electronic and magnetic amplifiers and instrument servomechanisms. Two of his specialties were the designing of all required test equipment and the productizing of components for magnetic control systems. Henry is an electrical engineer, having been graduated from Columbia University in 1948. His undergraduate work at the University of Michigan was interrupted by five years of military service with the Army Signal Corps, where his electrical interests were applied to radio communications. Since leaving the Army in 1946, he completed his study at Columbia, taught courses in electrical theory, radio and television maintenance, and, like Bill Deacy, had an opportunity to practice industrial engineering—in Henry's case it was the planning of a plant layout and production system for a New York corporation.

Bill Deacy was transferred and thoroughly absorbed by the end of November in his new work at Reeves Soundcraft Corp., 10 E. 52d St., New York 22. Reeves manufactures magnetic recording tapes, films and television tubes. Bill is primarily occupied with Reeves' new program of putting magnetic stripes on film. Bill, who is a product of the Lehigh University School of Electrical Engineering, spent three and one-half years with the George S. May Co., during which he applied his industrial management talents to complete overhaul of an enormous commercial laundry and, among others, to a wire cloth mill. For two years before the United States was involved in the war in Africa, Bill worked with the Overseas Division of Douglas Aircraft on the construction of air bases across Africa, the Middle East and India. On return to this country in 1943, he joined the staff of the American Standards Association and, while working with J. W. McNair at ASA, he made an indelible mark in the electrical components and photographic war standards work sponsored by the War Production Board and in which this Society played a major role. For over two years, Bill has been, in effect, Assistant Engineering Vice-President for our Society, and his contributions are not only well known but are well documented by the technical material published in the JOURNAL. We all wish him the best of good fortune in his new venture.

Engineering Committees Activities

Although neither the number of man hours spent at committee meetings nor the bulk of the meeting minutes which follow is a measure of useful results, they are both clear signs that members are active on Society projects and that something is being accomplished. From that point of view, members who attended the 68th Convention ran up an impressive score: 116 of them attended 11 different meetings over the 5 days. In the process, they generated enough rational discussion and arrived at enough conclusions to fill 71 pp. of formal minutes on a variety of subjects. Several merit mention in this general review of those proceedings.

Screen Brightness

A nationwide survey now being made of screen lighting conditions in about 100 motion picture theaters was discussed by the Screen Brightness Committee, and

a report on the West Coast portion of that survey, recently completed under Charlie Handley's guidance, was reviewed. The members agreed upon procedures to be followed by local survey teams in the remaining theaters. The next step calls for a series of incident and reflected light readings in New York film laboratory screening rooms. One of the major objectives of this project is to provide studios and film laboratories with data on present and recommended practices for theaters. Another is to tell projection equipment manufacturers how the equipment they make is actually used. Better understanding of current theater projection room practices and knowledge of light levels employed should be of considerable help to the general cause of improved picture quality. Chairman of the Committee is Wallace Lozier.

Test Film Quality

F. J. Pfeiff called a meeting of his Test Film Quality Committee to study the best possible combination of procedures which would insure maintaining high overall quality of the many test films produced by the Society and sold both through the Society and through the Motion Picture Research Council. A number of details were considered at length and it is likely that this new committee will be handing out specific projects at its next meeting early in 1951.

Color

The Color Committee, under the Chairmanship of Dr. H. H. Duerr, again looked into the use of lead sulfide phototubes with motion picture sound tracks in color. At the present time there are a variety of lead sulfide cells having different response characteristics, and in the interests of uniform reproduction, manufacturers now using them are testing all cells for response in the infrared. The Committee hopes to arrive at a standard test which manufacturers may apply and which would pave the way for general adoption of the lead sulfide cell, if they feel that the change is a beneficial one. Original plans to prepare and publish a comprehensive review of all motion picture color processes now in use were upset by the reluctance of some film companies to supply the essential information. A new angle of attack is being considered, with the hope that it will be more productive. A subcommittee was appointed to arrive at a more descriptive term than "color temperature" to describe the spectral characteristics of light sources used in commercial color photography.

Film Dimensions

Final adoption of proposed standards for 32-mm perforations on 35-mm raw stock has been again deferred because some members of Dr. E. K. Carver's Committee on Film Dimensions feel that there was inherent danger in the ultimate slitting of 35-mm stock to the 16-mm width. Not all motion picture film is coated on safety base; therefore the possibility of nitrate film being slit still remains, as does the question of the moral obligation of those who are concerned with the standardization of film dimensions. A standard would, however, be an aid to equipment designers and manufacturers.

Work over the past several years on a proposed single negative-positive perforation for 35-mm films has been drawing nearer completion. Several wear tests have been conducted on two possible combination sprocket holes and the committee has tentatively agreed to circulate a ballot on its recommendations for adoption of the new proposal, known as the Dubray-Howell perforation.

Several other committee projects reviewed at length during the 68th Convention will be reported upon in the January JOURNAL.

Films for Television

The Committee on Films for Television, under the Chairmanship of Dr. R. L. Garman, met informally to talk over work on the development of a proposed new release print leader that might serve equally well not only for both 16- and 35-mm films in theaters but also for television broadcasting use. Emulsion position problems in 16-mm release prints that have plagued users of educational films for years are now giving trouble in television projection. Prints made by commercial processes may have the emulsion and therefore the sound track facing the screen or facing the projection lamp and it is often necessary to splice both kinds of prints together on the same reel. If picture and sound track are in focus in one position, they are out of focus in the other and agreement on one position is essential if television picture and sound quality from a film program are ever to be predictably good.

Employment Service

Position Wanted: Belgian, 38; specialist in high-speed photography, educational and documentary films; thorough knowledge and experience script-to-screen production technique; first-class organizer; desires position as executive director of production plant (10 to 100 crew) in the States; married, more details on request. Write LB27, c/o Fred J. Pagenstecher, Seeley Lake, Mont.

New Members

The following have been added to the Society's rolls since the list published last month. The designations of grades are the same as those in the 1950 MEMBERSHIP DIRECTORY:

Honorary (H) Fellow (F) Active (M) Associate (A) Student (S)

Aronson, Arthur H., Cameraman, Taylor Film Co. **Mail:** 864 Linn Dr., Cleveland 8, Ohio. (A)

Avellana, Angel P., Recording Engineer, Movie Technical Services. **Mail:** 192 La Torre, Sta. Ana, Manila, Philippines. (A)

Bremer, Frank V., Vice-President, Bremer Broadcasting Corp. **Mail:** 1020 Broad St., Newark 2, N.J. (M)

Buscher, Chris P., Jr., American Television Inst. **Mail:** 1017 S. Oak Ave., Oak Park, Ill. (S)

Castagnaro, Dominick, Development Engineer, National Broadcasting Co. **Mail:** 1726-75 St., Brooklyn 4, N.Y. (A)

Faunce, Nat L., Audio-Visual Sales, Westcott, Slade & Balcom. **Mail:** 210 Waterman Ave., East Providence, R.I. (A)

Flaherty, Robert H., Hollywood Sound Institute. **Mail:** 5608 Lexington Ave., Los Angeles, Calif. (S)

French, Hubert, Television Technician, National Broadcasting Co. **Mail:** 795 Meeker Ave., Brooklyn 22, N.Y. (A)

Friedman, Thomas B., Chief Engineer, Television Station WXEL. **Mail:** 1900 E. 30 St., Cleveland, Ohio. (M)

Genis, Daniel, University of Southern California. **Mail:** 2714 Severence St., Los Angeles 7, Calif. (S)

Gretener, Edgar, Engineer, Dr. Edgar Gretener A.G., Ottenweg 25, Zurich 8, Switzerland. (M)

Haidar, Chicralla, University of Southern California. **Mail:** 903 W. 35 St., Los Angeles 7, Calif. (S)

Jacobs, Arthur A., Sound Technician and Production Assistant, Toby Anguish Productions. **Mail:** 11568 Blix St., North Hollywood, Calif. (A)

Jacobs, George G., Chief Engineer, KOTV, Cameron Television. **Mail:** 3050 S. Madison St., Tulsa, Okla. (A)

Johnson, Winston O., Mechanical Research Engineer, E. I. du Pont de Nemours & Co. **Mail:** Brinton Lake, Concordville, Pa. (M)

Kear, Frank G., Consulting Radio Engi-

neer, 1703 K St., N.W., Washington, D.C. (M)

Klynn, Herbert, Artist, United Productions of America. **Mail:** 4440 Lakeside Dr., Burbank, Calif. (A)

Krone, Robert, University of Southern California. **Mail:** 3713½ McClintock Ave., Los Angeles 7, Calif. (S)

Kuehn, Rudolph, Television Development Engineer, National Broadcasting Co. **Mail:** Apt. 2, 655 Bryant Pl., Ridgefield, N.J. (A)

Maasdam, Felber, Cameraman, Soundman, 410 N. Rossmore, Hollywood, Calif. (M)

McCandlish, Doris, Color Technician, Color Service Co., Inc. **Mail:** 36 Claremont Pl., Mt. Vernon, N.Y. (A)

McMurray, Glenn D., University of Southern California. **Mail:** 3422 S. Flower, Los Angeles 7, Calif. (S)

Miller, Brainard H., University of Southern California. **Mail:** 835 W. 32 St., Los Angeles 7, Calif. (S)

Mourad, A. Z., Sub-Manager, United Films Co. **Mail:** Bahari Building, 1, Ismailieh Square, Flat No. 19, Cairo, Egypt. (A)

Newman, Harold H., Director of Television, Century Theatres, 132 W. 43 St., New York, N.Y. (A)

Newman, Sydney C., Executive Producer, National Film Board of Canada, John & Sussex Sts., Ottawa, Ontario, Canada. (A)

Painter, Richard O., Assistant Head, Electronics Dept., General Motors Proving Ground. **Mail:** 415 E. Commerce, Milford, Mich. (A)

Schubert, Walter M., Motion Picture Sound Technician, Altec Service Corp. **Mail:** 561 N.W. 42 St., Miami, Fla. (M)

Schubert, Wenzel J., Sales Engineer, Fairchild Camera & Instrument Corp. **Mail:** 51-01 39 Ave., Long Island City, 4, N.Y. (A)

Schwartz, Walter A., Part Owner, Perfect Film Laboratory. **Mail:** 156 E. 184 St., Bronx, N.Y. (A)

Sebern, Theodore W., Assistant Director, Walt Disney Productions. **Mail:** 726 N. Lincoln Ave., Burbank, Calif. (A)

Shearer, B. F., Jr., Sales Manager, B. F. Shearer Co. **Mail:** 2318 Second Ave., Seattle, Wash. (A)

Sinha, J. K., University of Southern California. **Mail:** "Devashram," Mithapur, Patna, G.P.O., Patna, Bihar, India. (S)

Sollenberger, George A., Jr., Sound Technician, Hughes Sound Films. **Mail:** 759 Race St., Denver, Colo. (A)

Taylor, Stanley E., University of Southern California. **Mail:** 921 Ireland Ave., Muskegon, Mich. (S)

Transue, Laurence F., Research Chemist, Photo Products Dept., E. I. du Pont de Nemours. **Mail:** Du Pont Club, Parlin, N.J. (M)

Tsu-Ming, Hu, University of Southern California. **Mail:** 1156 W. 36 Pl., Los Angeles, Calif. (S)

White, J. D., Contact Engineer, Radio Corporation of America. **Mail:** 20-20 Calyne Dr., Apt. 11, Fairlawn, N.J. (A)

Zupansky, Milo, American Television Inst. **Mail:** 5327 N. Winthrop Ave., Chicago 40, Ill. (S)

CHANGES IN GRADE

Carter, William H., Jr., Vice-President, General Manager, Carter Music Co. **Mail:** 1201 Leeland Ave., Houston 2, Tex. (A) to (M)

Gaylord, Lt. Col. James L., Commanding Officer, Lookout Mountain Laboratory, USAF. **Mail:** 1000 Kagawa, Pacific Palisades, Calif. (S) to (A)

Kantor, Bernard R., Assistant Sound Technician and Lighting Engineer, Lookout Mountain Laboratory, USAF. **Mail:** 901 W. Exposition Blvd., Los Angeles 7, Calif. (S) to (A)

Moyse, Kern, President, Peerless Film Processing Corp., 165 W. 46 St., New York 19, N.Y. (A) to (M)

Weiner, Stuart A., Motion Picture Photographer, Board of Water Supply, City of New York. **Mail:** Box 748, Tempe, Ariz. (A) to (M)

Obituary

Anthony G. Wise died in Los Angeles on October 4. He was born in 1882 in Freeport, Ill. He worked for Bell & Howell Co. and was also associated with the Consolidated Laboratory before 1925 when he joined Metro-Goldwyn-Mayer where he was Laboratory Engineer. He was a regular attendant at Society meetings, and his technical contributions in committees and meeting discussions materially aided the industry. He had been a member of the Society since 1930.

Papers Presented at the Lake Placid Convention, October 16–20

LISTED BY SESSIONS

MONDAY AFTERNOON

Newland F. Smith, WOR-TV, New York, "Improved Video System for Television Studios."

H. M. Gurin, National Broadcasting Co., New York, "Lighting Methods for Television Studios."

J. L. Sheldon, Corning Glass Works, Corning, N.Y., "Characteristics of All-Glass Television Tubes."

Peter Goldmark, Columbia Broadcasting System, New York, "Color Television."

W. L. Norvell, Remington Rand, Inc., New York, "Television Application in Industry, Business, Education and Research."

TUESDAY MORNING

R. L. Garman, General Precision Laboratories, Inc., Pleasantville, N.Y., "Films for Television Committee Report."

W. K. Grimwood and T. G. Veal, Kodak Research Laboratory, Rochester, N.Y., "Dynamic Transfer Characteristic of a Television Film Camera Chain."

Thomas T. Goldsmith, Jr., Allen B. DuMont Laboratories, Passaic, N.J., "Engineering Aspects of Teletranscriptions."

Jerry Fairbanks, Jerry Fairbanks, Inc., Hollywood, Calif., "Motion Picture Production for Television."

L. W. Morrison, Bell Telephone Laboratories, Murray Hill, N.J., "Wire Television Transmission in Telephone Areas."

F. N. Gillette, General Precision Laboratories, Pleasantville, N.Y., "Joint RTMA-SMPTE Committee on Television Film Equipment Report."

TUESDAY AFTERNOON

F. T. Bowditch, National Carbon, Cleveland, Ohio., "Activities of Society's Engineering Committees."

G. C. Misener, Ansco, Binghamton, N.Y., "Application of Ansco Color Positive Film, Type 248."

A. C. Lapsley and G. P. Weiss, E. I. du Pont de Nemours & Co., Parlin, N.J., "A Versatile Densitometer for Color Film."

Karl Freund, Photo Research Corp., Burbank, Calif., "Simplified Index for Color of Illuminants."

Lloyd E. Varden, Pavelle Color, Inc., New York, "Semiautomatic Color Analyzer."

R. Hodgson and J. Hammer, Paramount Pictures Corp., New York, "High-Temperature Film Processing—Its Effect on Quality."

L. Katz, Raytheon Manufacturing Co., Waltham, Mass., "Ultrarapid Drying of Motion Picture Film by Means of Turbulent Air."

WEDNESDAY MORNING

L. T. Goldsmith, Warner Brothers Pictures, Inc., Burbank, Calif., "Sound Committee Report."

G. R. Crane, J. G. Frayne and E. W. Templin, Westrex Corp., Hollywood, Calif., "Professional Magnetic Recording System for 35-, 17½- and 16-Mm Films."

Loren L. Ryder, Paramount Pictures Corp., Hollywood, Calif., "Motion Picture Equipment and Methods for Editing Magnetic Films."

R. H. Ranger, Rangertone, Inc., Newark, N.J., "Editing Advantages Inherent in Quarter-Inch Magnetic Tape."

John G. Frayne, Westrex Corp., Hollywood, Calif., "Electrical Printing."
M. Rettinger, Radio Corporation of America, RCA Victor Div., Hollywood, Calif., "A-C Magnetic Erase Heads."

WEDNESDAY AFTERNOON

J. H. Waddell, Wollensak Optical Co., Rochester, N.Y., "High-Speed Photography Committee Report."
John H. Hett, New York University, Bronx, N.Y., "High-Speed Schlieren Studies of Flames."
Malcolm D. Pearson, Whitin Machine Works, Whitinsville, Mass., "High-Speed Photography in Textile Industry."
Messrs. Andres and Roganti, Photo Engineering Group, Wright Field, Dayton, Ohio, "Instrumentation at Air Materiel Command."
Myron Prinzmental, Institute of Medical Research, Los Angeles, Calif., "Photography of the Heart."

THURSDAY MORNING

Subcommittee on Lighting for High-Speed Photography Report.
H. P. Mansberg, Allen B. DuMont Laboratories, Clifton, N.J., "Oscillograph Recording Camera."
Harold E. Edgerton, Massachusetts Institute of Technology, Cambridge, Mass., and Charles W. Wyckoff, Edgerton, Germeshausen & Grier, Inc., Boston, Mass., "A Rapid-Action Shutter With No Moving Parts."
Richard R. Conger, Naval Photographic Center, N.A.S., Anacostia, Washington, D.C., "Underwater Cinematographic Techniques."
J. H. Waddell, Wollensak Optical Co., Rochester, N.Y., "New Approach to High-Speed Photographic Sales and Service."

THURSDAY AFTERNOON

E. K. Carver, Eastman Kodak Co., Rochester, N.Y., "Film Dimensions Committee Report."
Edward Schmidt, Reeves Soundcraft Corp., Long Island City, N.Y., "Modernized Commercial Sound Recording."
J. A. Maurer, J. A. Maurer, Inc., Long Island City, N.Y., "Linearity Compensation Methods in Variable-Density Recording."
W. V. Wolfe and W. F. Kelley, Research Council, Inc., Hollywood, Calif., "Recent Studies on Standardizing the Dubray-Howell Perforations for Universal Applications."
R. P. Shea, Producers Service Corp., Hollywood, Calif., "Problems of Registration in Process Photography."

THURSDAY EVENING

A. E. Murray, Bausch & Lomb Optical Co., Rochester, N.Y., "Diffuse and Collimated 'T-Numbers'; A Review and Description of New Bausch & Lomb Equipment."
L. G. Dunn, RKO-Radio Pictures, Hollywood, Calif., "A Graphic Example of Modern Composite Cinematography."
W. F. Kelley and W. V. Wolfe, Research Council, Inc., Hollywood, Calif., "Technical Activities of the Motion Picture Research Council."

FRIDAY MORNING

B. Passman, International Projector Corp., Bloomfield, N.J. and J. Ward, General Precision Laboratories, Pleasantville, N.Y., "New Theater Sound System."
Harold N. Christopher, Bell Telephone Laboratories, Murray Hill, N.J., "Observer Reaction to Nonsimultaneous Presentation of Pictures and Associated Sound."
M. T. Jones and F. T. Bowditch, National Carbon, Cleveland, Ohio, "Carbon Arc Characteristics That Determine Motion Picture Screen Light."

Benjamin Schlanger and William A. Hoffberg, Theater Engineering and Architecture Consultants, New York, "Effects of Television on the Motion Picture Theater."

FRIDAY AFTERNOON

D. E. Hyndman, Eastman Kodak Co., Rochester 4, N.Y., "Theater Television Committee Report."

R. L. Garman and R. W. Lee, General Precision Laboratories, Inc., Pleasantville, N.Y., "Comprehensive Proposal for a Closed Loop Theater Television System."

R. V. Little, Jr., Radio Corporation of America, RCA Victor Div., Camden, N.J., "RCA PT-100 Theater Television Equipment."

L. E. Swedlund and C. W. Theirfelder, RCA Victor Division, Lancaster, Pa., "Projection Kinescope 7NP4 for Theater Television."

E. Stanko and C. Y. Keen, Radio Corporation of America, RCA Service Co., Inc., Glouster, N.J., "Installation of Theater Television Equipment."

HONORARY MEMBERS

Lee de Forest
Edward W. Kellogg
A. S. Howell
V. K. Zworykin

The distinction of Honorary Membership in the Society is awarded to living pioneers whose basic contributions when examined through the perspective of time represent a substantial forward step in the recorded history of the arts and sciences with which the Society is most concerned.

SMPTE HONOR ROLL

Louis Aimé Augustin Le Prince
William Friese-Greene
Thomas Alva Edison
George Eastman
Frederic Eugene Ives
Jean Acme Le Roy
C. Francis Jenkins
Eugene Augustin Lauste
William Kennedy Laurie Dickson
Edwin Stanton Porter
Herman A. DeVry
Robert W. Paul
Frank H. Richardson
Leon Gaumont
Theodore W. Case
Edward B. Craft
Samuel L. Warner
Louis Lumiere
Thomas Armat

Elevation to the Honor Roll of the Society is granted to each distinguished pioneer who during his lifetime was awarded Honorary Membership or whose work was recognized subsequently as fully meriting that award.

Journals Out of Stock: The Society's stock of JOURNAL issues for March, Part II, July, August, September, 1949, and February, 1950, has been exhausted as a result of an unexpected increase in demand and the Society's Headquarters is anxious to purchase a stock of each. Members or libraries having extra copies available are invited to send them in. The going price is 75c.

SMPTE Officers and Committees: The Roster of Society Officers was published in the May JOURNAL. For Administrative Committees see pp. 515–518 of the April 1950 JOURNAL. The most recent roster of Engineering Committees is on pp. 337–340 of September 1950 JOURNAL.

Membership Certificates

If you are proud of your membership in the Society, you will want an attractive hand engrossed membership certificate suitable for framing. The certificate carries your name and the date you were admitted to membership in the Society, and is personally signed by the President and the Secretary. The price is $1.50, plus 3¢ sales tax for members who live within New York City. Your check should accompany the order, and please allow two weeks for the certificate to be made up and mailed to you.

1950 Membership Directory

Copies of the 1950 *Membership Directory* are still in stock and will be furnished without charge to any member who may have mislaid the one he received as Part II of the *Journal* for May.

Application forms and booklets describing the Society and its work will also be supplied, on request, to members who wish to invite their friends or associates to apply for membership.

Sustaining Members

OF THE

SOCIETY OF MOTION PICTURE AND TELEVISION ENGINEERS

Altec Companies
Ansco Corporation
Audio Productions, Inc.
Bausch & Lomb Optical Co.
Bell & Howell Co.
Bijou Amusement Co.
Blumenfeld Theaters
J. E. Brulatour, Inc.
Buensod-Stacey, Inc.
Burnett-Timken Research Laboratories
Byron, Inc.
The Calvin Company
Cinecolor Corp.
Cineffects, Inc.
Geo. W. Colburn Laboratory, Inc.
Consolidated Film Industries, Inc.
Helene Curtis Industries, Inc., Natco Division
DeLuxe Laboratories, Inc.
Du-Art Film Laboratories, Inc.
E. I. du Pont de Nemours & Co.
Eastman Kodak Company
Fabian Theaters
Max Factor & Co.
Jerry Fairbanks, Inc.
Fordel Film Laboratories
General Electric Company
General Precision Equipment Corp.

- Ampro Corp.
- Askania Regulator Co.
- General Precision Laboratory, Inc.
- The Hertner Electric Co.
- International Projector Corp.
- J. E. McAuley Mfg. Co.
- National Theatre Supply Co.
- Strong Electric Corp.

Guffanti Film Laboratories, Inc.
Hunt's Theatres
Industrial Development Engineering Associates
Interboro Circuit, Inc.
Interstate Circuit, Inc.
Jam Handy Organization, Inc.
Kollmorgen Optical Corp.
March of Time
J. A. Maurer, Inc.
Mitchell Camera Corp.
Mole-Richardson, Inc.
Motiograph, Inc.
Motion Picture Association of America, Inc.

- Allied Artists Productions, Inc.
- Columbia Pictures Corp.
- Loew's, Inc.
- Paramount Pictures, Inc.
- Republic Picture Corp.
- RKO-Radio Pictures, Inc.
- Twentieth Century-Fox Film Corp.
- Warner Brothers Pictures

Movielab Film Laboratories, Inc.
National Carbon
National Cine Equipment, Inc.
National Screen Service Corp.
National Theaters Amusement Co., Inc.
Neighborhood Theatre, Inc.
Neumade Products Corp.
Producers Service Co.
Projection Optics Co., Inc.
Prudential Circuit
Radio Corporation of America, RCA Victor Division
Reeves Sound Studios, Inc.
SRT Television Studios
Shelly Films, Ltd.
Technicolor Motion Picture Corp.
Terrytoons, Inc.
Theatre Holding Corp., Ltd.
Titra Film Laboratories, Inc.
United Amusement Corp., Ltd.
Universal Pictures Co.
Westinghouse Electric Corp.
Westrex Corp.
Wilding Picture Productions, Inc.